

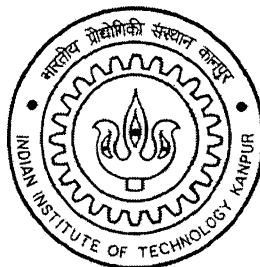
# **BOMB DISPOSAL & BOMB SQUAD CARRIER VEHICLE**

A Thesis submitted  
In Partial Fulfillment of the requirements  
For the Degree of

## **MASTER OF DESIGN**

by

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**DESIGN PROGRAMME  
INDIAN INSTITUTE OF TECHNOLOGY KANPUR**

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# CERTIFICATE



It is certified that the work contained in the thesis entitled, "DESIGN OF BOMB SQUAD CARRIER VEHICLE" by *Mr. Hitesh Bagai* has been carried out under my supervision and that this work has not been submitted elsewhere for a degree.

Dr. Amit Ray

Professor

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-- July 7, 2004

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# ABSTRACT

‘Bomb Disposal and Carrier Vehicle’ is a project which involves the design and development of a Carrier vehicle for the Bomb Disposal team.

The vehicle will house in the equipments necessary for any Bomb Disposal activity and extra equipments for the team. Activity of Bomb Disposal is a critical task as it involves lives of civilians. It also involves the risk of financial and physical loss. The time and magnitude of a bomb blast is also unknown till the time it is detected and analyzed. The vehicle will cater to all the needs of the team thus involving the functional aspect to a larger extent.

There are existing carrier vehicles available in the international market but catering to specific geographic locations. Thus, the user in India would require the carrier vehicle according to Indian urban conditions where actually the vehicle is going to serve. Thus, a study was required to analyze the Indian conditions and facilities provided by the international market in the vehicle. It was also necessary to understand and analyze the criticality of the Bomb disposal activity to a large extent as it governs the physical mass movement during the activity. It was also utmost important to study and design the equipment on the basis of systems design approach as lots of moving parts are involved in the project.

Taking into consideration, systems design, complexity of the project and the task, the carrier vehicle has to be designed simple and rugged for the Indian conditions, user friendly and with less number of moving parts to reduce the maintenance hassles. The other major concerns in this project were on human ergonomics, manufacturability of the vehicle with all the factors in effect.

# Chapter 1

## INTRODUCTION

### 1.1 BACKGROUND

Man is the only creature on this earth which expresses its thoughts – Good or Bad! Some express it through words and some take the help of violence. Indian society is facing the vast differences of culture, religion, geography, etc. with the orthodox rules from the age of ruler ship. Today's society has communal riots, loss of physical and financial losses, loss of civilian lives and many more aspects in its big list of problems. In today's context, these communal riots have different forms ranging from mines to suicidal bombings, targeting general citizens to distinguished personalities, public places to government institutions and many more.

A full proof and 'safe-mode plan' is required to prevent these losses from happening.....as generations will come and generations will vanish in the girth of insanity. I as a designer try to prevent these losses from happening and maintain the sense of security in the minds of a citizen through this thesis.

### 1.2 OBJECTIVE

Massive explosions in New York, Mumbai, London and other major cities worldwide clearly demonstrate that important financial districts have become prestigious targets for terrorist organizations, regardless of their motives. Factors such as the accessibility of information on the construction of bomb devices, relative ease of manufacturing, mobility and portability, coupled with significant property damage and injuries, are responsible for significant increase in bomb attacks all over the world. In addition to causing significant loss of life, these bombs can severely disrupt trade and economic transactions. Further, modern satellite communications broadcast grisly bomb scene images around the world within minutes, adding to the lure of this type of target for groups seeking media publicity.

The primary law enforcement objective must be to keep such incidents from occurring. However, as vividly revealed in London and New York, a democratic society with freedom of movement makes prevention difficult, at best. Therefore, police departments must be prepared to deal with the aftermath of bomb detonations in highly concentrated business districts to reduce deaths and injuries, to preserve the crime scene, to investigate the crime successfully, and to help local businesses recover quickly from the damage.

Anti social elements are playing a game all over the world, India is no different than those countries. They play on the key factors such as the religious, cultural and geographical factors. They have the best of armaments to attack the civilians and places, rupturing a strong economy like India with financial and security problems. One of the key elements they have been using is Explosive attacks. These explosives are available in many forms in open market as well as underground market. They are basically targeted to create a sense of Insecurity amongst a normal citizen and thus fracture the normal life in a country.

Thus, the objective of this thesis is to prevent bomb attacks as far as possible. This objective has always been on the prime list of Indian Defense research organizations (DRDO). It is necessary to prepare the contingency plans for prevention of such attacks whether in a commercial complex or in the valleys of Jammu and Kashmir. A plan is also required to tackle the repercussions of a bomb explosion which usually affects lot than the real Bomb attack.

### 1.3 CLIENTS

Primary Client – Onio Design Pvt. Ltd., Pune

Secondary – Research & Development Establishment(R&DE (Engineers))



### 1.3.1 ONIO DESIGN PVT. LTD., PUNE

(Website: [www.oniodesign.com](http://www.oniodesign.com))

Onio Design Pvt. Ltd. is a six year old adventure of two minds, design graduates from National Institute of Design, Ahmedabad. With a current strength of 12 people, based at Pune and strategic partnerships across the shores, Onio Design is spearheading the new-age design studio revolution in India.

Onio is into design of consumer products that are closer to senses...audio, video, perfumes, cosmetics, personal accessories.... highly trend conscious.....products that are driven by 'desire to be different'...which are finally to be Retailed.....that means faster development cycles, razor sharp price consciousness, which other consumer goods are not familiar with....

Their Core Services: Innovation Design & Branding, Product Repositioning through Design, Strategic Innovation

### 1.3.2 RESEARCH & DEVELOPMENT ESTABLISHMENT (ENGINEERS)

[R&DE (E)], PUNE

(Website: <http://www.drdo.com/labs/combat/r&de/index.shtml>)

- **History** : Research & Development Establishment (Engineers), Pune was established on 09 February 1962 by the amalgamation of a part of the Technical Development Establishment (Vehicles), Ahmednagar and the Inspectorate of Engineering Stores Calcutta to have a nodal establishment for meeting the requirement of advanced technology equipment for Army engineers.
- **Areas of Work:** R&DE (Engrs) provides engineering support for different types of military hardware to all the three services and also undertakes consultancy projects for other government departments. The list of achievements include Design of High Pressure Hydraulic Actuators, Circuits & High Pressure Compressors, High Frequency Tools, Non Conventional Power Sources, Auxiliary power unit, Thermal Conditioning & Mobile cooling System, Pressure Vessel Technology Environmental & Climatic Test Facility, NBC Survival System, Robotics, Weapon Launch System, etc.

## 1.4 ORGANIZATION OF THESIS

Different chapters in the thesis concentrate on the complete process of the design. The Chapter 2 looks after the Initial research and analysis for the problem definition. The chapter 2 concentrates on the Information assimilation for the Problem already defined and ultimately converge the need statement, aims and objectives.

Chapter 4 is the final part of the design process i.e. conceptualization and detailing. The chapter covers the various design directions and mock-ups done during the design process. It also tells the various details which are thought before the execution of the bus is taken care of.

## Chapter 2

# RESEARCH DIRECTIONS

### 2.1 INTRODUCTION

The philosophy of the research is to create devices to protect the lives of the personals and public from various anti-social activities. The primary goal of the research is to protect human lives from 'Bomb explosion' that are planted by anti-social elements.

#### 2.1.1 RESEARCH – OVERALL AND DETAILS BASED

Research is basically divided in two parts, One that deals with the overall possibilities of satisfying the aim of this thesis and Second, the research or the study of the details and minor factors of the project. The first one decides the direction of the design process and the second one decides the minute details of the design after a design is frozen. The research will also involve the problem structuring part.

#### 2.1.2 ANALYSIS

- a. Analysis involves the preparation of base for decisions regarding design directions.
- b. The other important part of analysis is to study parallel products in detail.

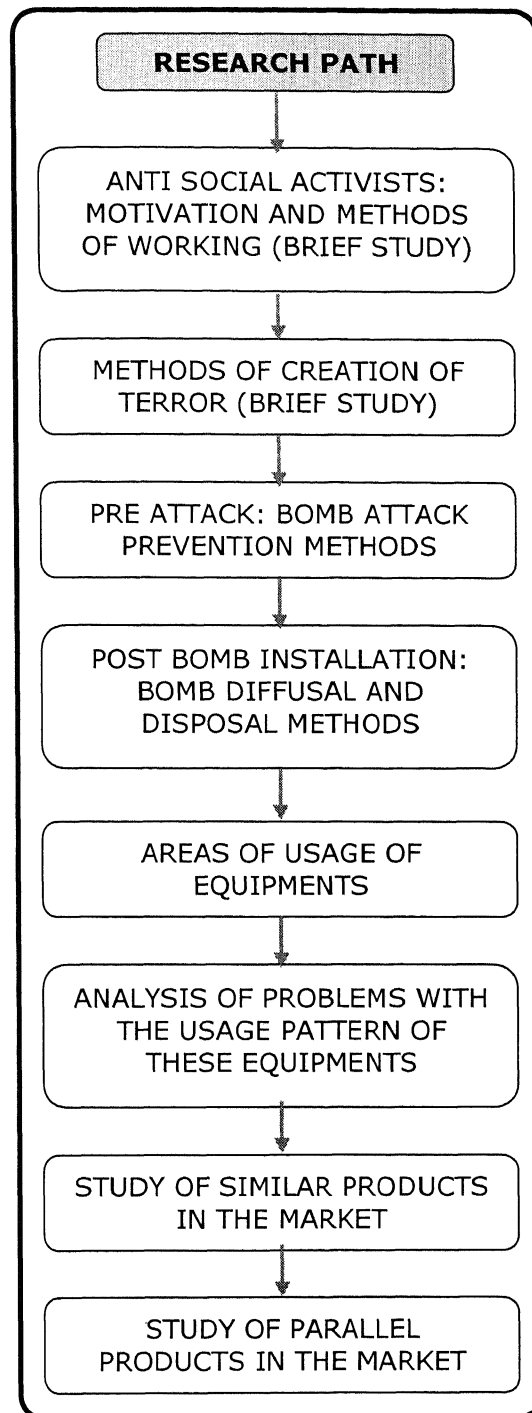
### 2.1.3 RESEARCH PATH

The research directions are shown in Fig. 2.1. Some of the studies were carried out in brief as the concentration was to understand the different methods already in place.

The study of various anti-social activists and their course of action or methodology give an insight to their ways and means of creating terror. It also throws light on the intensity of their operations and targets through which they can create maximum damage to a particular nation or society with available resources.

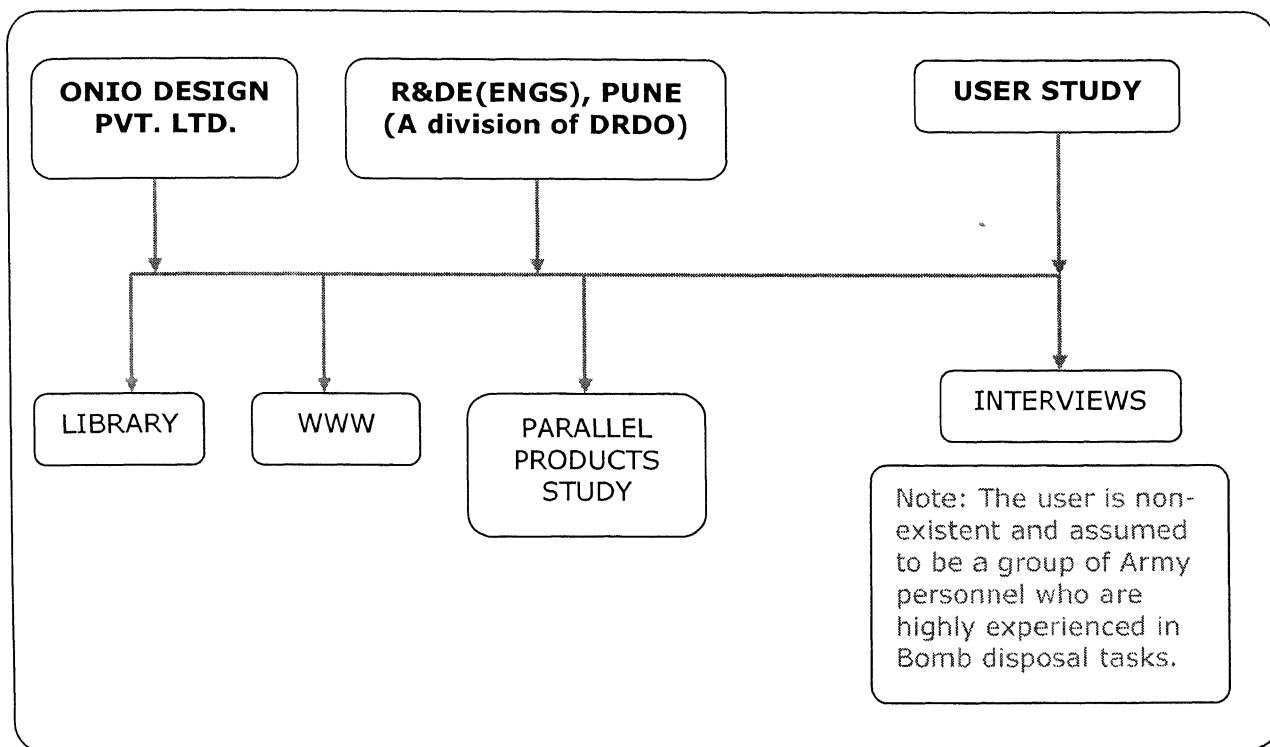
The research also concentrates on various Bomb attack prevention methods and ultimately if the bomb is planted then the diffusal and disposal of the same. The study is also done to understand the present and possible area and range of usage of these bomb disposal and diffusal equipments to mark its important factors which will be critical for design.

The next step in the research involves the study of similar and parallel products available in the market. This helps in understanding the benefits and disadvantages of these existing products.



**Fig. 2.1: Flow chart showing the Research directions**

### 2.1.4 SOURCES OF DATA COLLECTION



**Fig. 2.2: Sources of Data Collection**

Various sources of information of data collection for research purposes are displayed in the chart No.--. The three basic groups involved in the project are Onio Design Pvt. Ltd., R&DE (Engineers) and User themselves.

As the user is non-existent so their profile is assumed and considered for the study purposes. The traits of highly experienced Army personnel are thus followed as the profile of the user.

## 2.2 RESEARCH DIRECTION 1 - ANTI SOCIAL ACTIVISTS

Table No. 2.1 gives the brief information regarding the motivation, agents of violence, activities of the anti-social elements and some special remarks about the types of anti-social elements present in our society.<sup>1</sup>

<b>Motivation</b>	<b>Agents of Violence</b>	<b>Activities</b>	<b>Remarks</b>
Nationalism - Separatism	Separatist & regional autonomy movements; ethnically-based contenders for power	Anti-government, intercommunal violence; attacks on NGOs and peacekeepers	Agreements in some protracted European conflicts; conflicts continue in Asia, ME & Sub-Saharan Africa
Religious - Extremism	Extremist fundamentalists of all religious persuasions	Mass casualty attacks on civilian targets	Most serious international threat
Ideology	Right & left wing extremists (skinheads, racists, anti-racists, anarchist militias)	Hate propaganda; anti-immigrant violence; bombing	Anti-immigrant violence peaked in Europe in early 90s; Largely US threat but with recent incidents in the UK
Single Issue	Animal rights; environmentalist; anti-abortion extremists	Sabotage, mail bombs	Significant threat in oil industry
State & State-Sponsored	Oppressive regimes	Sabotage and use of chemical weapons	

**Table 2.1: Terrorist Activities**

### 2.2.1 ANALYSIS

From the study so far the following analysis can be achieved:

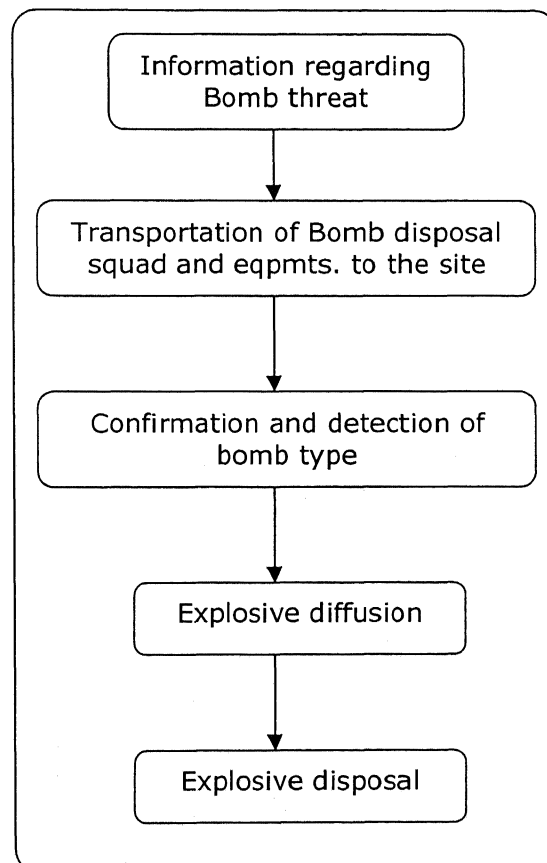
- The anti-social activists are highly trained and motivated professionals who don't care for their own lives and ready to die for the cause of their group. So in case of suicidal bombings, there is not chance of saving general public from the wrath unless there is any plan to dispose off the bomb before it explodes.
- The activities of these groups are very confidential and uncertainty level is high and thus their next movement cannot forecast by the central intelligence agencies.
- The chances of traitors within the group are very less. This leads to very less chance of information of bomb threats reaching the intelligence agencies in time to prevent the placement of explosive devices.
- They work as a single man army rather than in a group thus nobody else knows about the next movement of that person except him himself and the leader of the group.
- To overcome, the dangers of bomb installation in a public place, central intelligence agencies have devised special security and detection systems but because of the highly volatile activity of these activists, all the arrangements are a failure.



### 2.3 RESEARCH DIRECTION 2 - POST BOMB INSTALLATION: BOMB DIFFUSAL AND DISPOSAL METHOD

(Note: The user is assumed for the data acquisition regarding the bomb disposal methods. The data regarding the user (Explosive disposal squad) is as per the data available on the World Wide Web (an open source) regarding these squads and the equipments used by them.

Detection of presence of bomb in a public place without any prior warning by the anti-social activists or intelligence services is almost impossible. Various detection systems have also failed in front of the highly motivated human brain. It is evident from the incidents of the history, that on maximum of the occasions these activists have been successful in their mission to a large extent, causing a big life loss, financial losses and ultimately a loss of security in the minds of society. The amount of information available on the free and open information sources like World Wide Web (internet) is huge, for preparation of bombs, ranging from a home-made simple kerosene bomb to the worst of the bombs. It is very easy to break open the security locks and enter a well-guarded area.



**Table 2.2 Process of Bomb detection and disposal in case of post-bomb installation mode**

Thus, the last resort left for the security professionals is to work out the strategy of Bomb diffusal and disposal if a bomb is found in an area. All over the world, many defense agencies (Armed forces research labs) are concentrating on this area of explosives which deals with saving lives rather than loosing it. Bomb disposal involves the steps shown in the table 2.2.

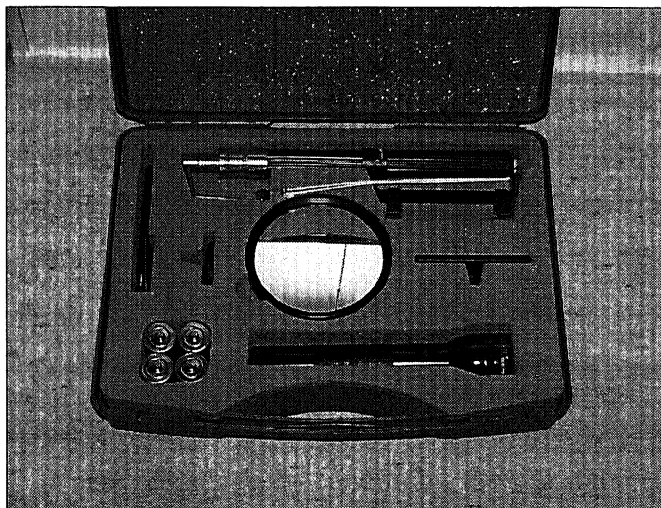
Explosive ordnance diffusal and disposal squad is a very important part of any armed forces as well as state police team. They basically constitute the experienced professionals in the field of understanding the explosive types, detection, diffusion and ultimately disposal of the same.

Upon receiving the information regarding the bomb threat or the bomb identification, the Explosives disposal squad moves to the site. The site is usually a highly crowded public place where one mistake can lead to the stampede kind of situations amongst the crowd.

### 2.3.1 BOMB DETECTION AND DISPOSAL EQUIPMENTS

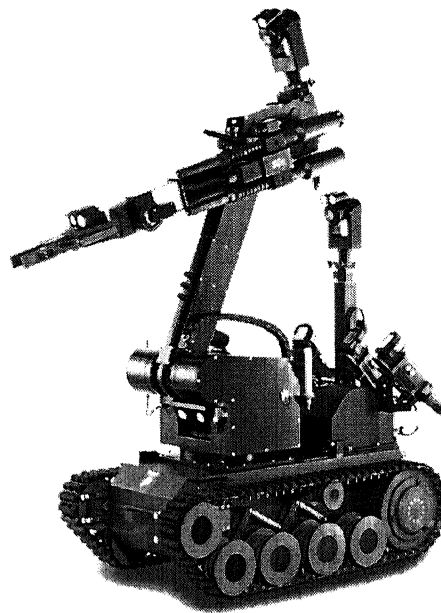
Explosive disposal squad generally carries all kinds of explosives identification equipments which can even recognize the kind of explosive which is planted. These equipments are of following types

- **Detection Equipments:** This category of equipments deals with the first stage of detection of bombs/explosives and recognizing the type of explosive. The various constituents are optical search kit, visual search kit, x-ray devices, electronic stethoscope, etc.



**Plate 2.1 Visual Explosives Search Kit**

- **Manipulator Equipments:** After the detection of the explosive, it has to be manipulated or shifted to a safer place where there is no hazard to the public and surrounding environment. For this various equipments with probing arms, manipulating arms are used. Two of the important parts of this category are Bomb Suit which saves the manipulator and Bomb Blanket which reduces the impact of the bomb incase of explosion. It involves also the Robot which is remote controlled and has different attachments of detection and manipulation.



**Plate 2.2 IED Response Vehicle with manipulator arm**

- **Disposal Equipments:** These equipments are basically the one which disrupts the bomb circuits, sometimes without exploding it and sometimes with an explosion under controlled conditions.
- **Peripheral Equipments:** Peripheral equipments constitute the equipments for self-defense of the squad, communication instruments, repairing and maintenance instruments, etc.

These equipments are carried on the basis of the requirements, site situation for e.g., In case of situations or places where the terrorist activities are too many in numbers, there the need of mine detection will also be there. The same factors also decide the mode of travel for the squad. In case of emergency conditions, the squad travels by air and in normal conditions it travels by rail or road.

Highly trained dogs are also used for the detection of explosives and thus included sometimes in the explosive diffusion and disposal squad. These dogs are trained to understand the smell of explosives and then the location of it and because of highly developed organs of smell; these dogs are a big asset to any explosive disposal team. This team can detect and diffuse the simple, electronic, chemical and biological categories of explosives and diffuse it successfully.

### **2.3.2 ANALYSIS**

From the analysis of the study of Explosive detection and disposal activity, following conclusions can be achieved,

- The Explosive disposal squad faces a big constraint of movement from one place to another. It also governs the movement time and safety of their costly equipments.
- The ED squad is a self-equipped team to tackle all kinds of problems regarding the diffusion and disposal of almost all kinds of explosives. Various highly developed and tested instruments for explosive diffusion are available.
- The post bomb installation phase is an important phase in the detection and diffusion of bombs as the location (may not be exact) is known.
- ED squad is an important part of the security squad in maintenance of safety and security of public and noted dignitaries (politicians).

### 2.3.3 INITIAL DESIGN DIRECTIONS (BRAIN STORMING)

Based on the study of Improvised Explosive device diffusion and disposal method, following design directions can be taken.

- **Design of smaller and advanced IED detection instruments** – The explosive disposal team faces a major constraint and that is the size of the equipments and its carriage cases. Some of the equipments are so fragile that it cannot be handled without its case and some of them are perfectly rugged for army/police personnel's hands.
- **Design of transportation system for the Explosive Disposal Team** – At present, the team travels by air on emergency calls and by rail or road in case of normal appointments. The biggest constraint here is again the carriage of so many equipments and its maintenance during the journey. Some of the processes of the detection and diffusal begin in the journey as they approach the site for e.g. Charging of general and back-up batteries, bomb suit arrangements, maintenance and repairing of the equipments, etc. Thus, a transportation system for the team which can carry all the equipments safely with the crew members will be a time saver and helpful to carry all the peripheral activities during the journey.
- **Design of Personal Safety and Security system** – This design direction will deal with the design of a personal safety system of a person which gets triggered with even a single spark. Many studies have proved that an explosive's real destructive criteria are its fire making capacity and impact. The personal safety system can take the impact and will be made of fire-retardant material thus securing the person inside.

## **2.4 RESEARCH DIRECTION 3 - NEED STATEMENT**

**To design and develop the transportation system for the explosive disposal squad.**

## RESEARCH & DATA COLLECTION OF THE PROJECT

The data collection at this stage concentrates on two different parts which are interrelated.

- User (Explosive Disposal Squad(EDS))
- Equipments for Explosive diffusion and disposal activity/task

### 2.4.1 USER

The user is **Bomb Squad** which is an assumption. The squad can be a part of State Police Force, Rapid action force or any armed forces division. Their mission involves detection and proper diffusion of bombs of wide variety e.g. chemical bombs, electronic bombs, mines, etc. Various details are mentioned in the Table 2.3.

Criteria	Data
No. of members in Bomb Squad	Total 8 members ( 6 highly skilled armed forces personnel, 1 driver and 1 guard)
Skills (For Explosive disruption and disposal task)	<ul style="list-style-type: none"> <li>• Detection and diffusion of various kinds of Improvised explosive devices for e.g., Chemical, electronic, bio-hazardous, etc...</li> <li>• Understanding of various electronic components (as the bomb can be in any package), chemical compositions, etc.</li> <li>• Handling of improvised explosive devices</li> </ul>
Tasks (Duty as a Bomb Squad member)	<ul style="list-style-type: none"> <li>• The render safe and disposal of explosive devices, suspicious packages, Weapons of Mass Destruction (WMD), and other hazardous items;</li> <li>• Providing VIP protection for visiting dignitaries;</li> <li>• Providing technical, operational and training support for various local, State and Federal agencies; conducts seminars for members of the CMPD and community members (business and individuals) about bomb threat response and safety. The goal of these seminars is to enhance individual awareness of potential explosive effects, proper reporting methods, search procedures, and to develop a proactive response to various types of threats.</li> </ul>
Range of Activity (zone of	Covering cities in diameter of 1000 kms

action)	
Demographic Information	<ul style="list-style-type: none"> <li>• Average Age : 35-45 years</li> <li>• Occupation : Part of State Police Force or any armed force division</li> <li>• Service : minimum of 10-15 years</li> <li>• Nationality : Indian</li> </ul>
Motivation	<ul style="list-style-type: none"> <li>• Patriotism, a zeal to serve the country and its citizens</li> <li>• Loyalty, towards the work, country and society who depend on them for security and safety</li> </ul>
Other Details	<ul style="list-style-type: none"> <li>• The job of a member of Bomb Squad is a highly risk oriented one with the risk of life. Many of the times the skill and presence of mind of Bomb squad decides the life and death of the whole squad and innocent citizens.</li> <li>• The job requires the psychological balance which when lost can be dangerous for all the members of the squad.</li> <li>• These members have to face the amputation of limbs due to unfortunate bomb explosions but still they continue to serve their country.</li> </ul>

**Table 2.3 Bomb detection and disposal squad – data collected on the basis of interviews**

(Note: To protect the bomb squads from the attack of terrorist or anti-social activists, the information is not revealed. These squads were attacked upon in volatile zones like Jammu & Kashmir region, Assam, etc. As the user group is assumed, the data is also gathered on the basis of study of armed forces personnel's demographic study and from open sources of information like World Wide Web.)

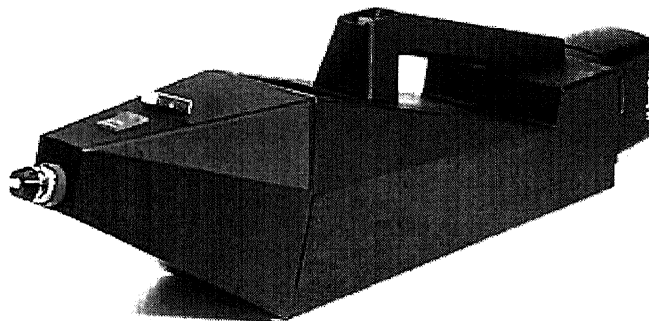


## 2.4.2 EQUIPMENTS FOR EXPLOSIVE DISRUPTION AND DISPOSAL TASK

There are various equipments used by Bomb Squad for disruption and disposal of an explosive which depends on the type of bomb being diffused. The equipments are categorized and enlisted below with their quantitative details which are necessary to understand the task flow and storage pattern.

### A. Portable Explosive Detector<sup>2</sup>

It is an advanced explosives detector that provides immediate detection and location of concealed explosives. Weighing only 3kg the detector is easily carried and allows security personnel to quickly detect and locate a wide variety of explosive devices including organ nitrate and plastic based explosives.



**Plate 2.3 Portable explosive detector**

Specifications for the portable explosive detector are mentioned in the table 2.4, which also mentions the dimensions of the detector, with box and without cover box. It also mentions the no. of chargers required with the instrument which again decides the space requirement.

Criteria	Specifications
Power Supply	12volt DC rechargeable battery cartridge (1 hour use, 1 hour recharge time )
Dimensions	Unit Dimensions (l×h×w): 510×140×110 mm (20×5.5×4.3")
Weights	Unit Weight: 3Kgs (6.6lbs)
Operating and Storage Temperatures	Operating: 0° C to 45° C (32° F - 113° F) Storage: 0° C to 50° C (32° F - 122° F)

**Table 2.4 Specifications of Portable explosive detector**

### **B. Non Linear Junction Detector<sup>3</sup>**

A portable, simple-to-use, advanced non-linear junction detector which discriminates between electronic targets and innocent return signals. Radiating a spectrally pure signal it detects the second and third harmonic return signal re-radiated by non-linear junctions (NLJs) found in all semiconductors such as diodes and transistors.

Using unique technology it compares the two harmonics return signals to provide information for the operator to discriminate between the various types of NLJ.

Designed for the security professional it is simple to use providing easy end-user friendly operation to detect active, dormant or non-operational electronic devices. This is an indispensable tool wherever there is a need to locate electronic devices.



**Plate 2.4 Non Linear Junction detector**

A Non Linear Junction Detector may be used to identify:

- Active or Live Bugs
- Inactive Bugs
- Turned On Bugs
- Turned Off Bugs
- Burned Out Bugs
- Dead Bugs
- Covert or Concealed Video Cameras
- Microwave Transmitters
- Remote Control or Remote Powered Bugs
- Resonant Cavity Devices
- Concealed Cellular, PCS, and GSM Telephones
- Electronic Timers for Hidden Bombs
- Wireless Microphones
- Hidden Tape Recorders (even broken ones)
- Covert Eavesdropping Devices

**Typical applications** for a non-linear junction detector are the following:

- **VIP Protection support**

The NLJD can be used to search for both 'bugs' and electronic IEDs prior to a VIP visit.

- **Threat response**

It can also be used for searching large complex areas where devices may be hidden in any number of places. e.g. incendiary devices placed in department stores or conference halls.

- **Post incident follow-up**

Because semi-conductors do not need to be powered to be detected, the NLJD can be used to find parts of circuits after an incident to provide forensic evidence or intelligence regarding the source of the device.

Criteria	Specifications
Dimensions	240×140×80mm. 2.4kg
Charger Dimensions	120×70×45mm. 0.4kg
Total dimension including case	530×330×210mm.
Weight (including case)	8.9kg

**Table 2.5 Specifications for NLJD**

### **C. Mine/Metal Detector<sup>3</sup>**

These are high sensitivity mine detector based on very high speed pulse induction technology and capable of exceptional performance against minimum metal mines.

The search head incorporates differential Rx coils which greatly reduce interference from external sources. The instrument is microprocessor controlled which also permits sophisticated signal processing. This, in conjunction with the novel head design, permits the detection of very small metallic objects even in the proximity of larger targets. Differential coils also enhance the ability of the equipment to operate in hostile conditions over mineralized soils, for example, without loss of sensitivity. The power supply circuit maintains a constant voltage ensuring maximum performance, whatever the state of the batteries.

The instrument is constructed as a single compact unit, eliminating the problem of cumbersome interconnecting cables, and supplied in a transit case with lightweight 'Danavox' style headphones and a soft pack.



**Plate 2.5 Mine-Metal detector in use**

Criteria	Specifications
Dimensions	Operating length : maximum - 1560mm, minimum - 1120mm Probe diameter : 300mm
Operating weight	2.4 kgs.
Transit Weight	10.0 kgs
Battery Life	at max. sensitivity - 12 hours continuous

**Table 2.5 Specifications for Mine-metal detector**

### D. Portable X-Ray kit

A compact portable X-ray computer based real time inspection system for the examination of suspect packages or other inaccessible areas where contraband may be hidden. Suited for use with the 600-379 X-ray generator.

#### Inspection system

The inspection system comprises a video camera unit which is placed behind the suspect package to receive the X-ray image which is then relayed along a 50 meter cable to a powerful laptop computer for inspection. The system is extremely easy to set up and use and can be powered from the mains or its own internal rechargeable batteries for up to 2 hours between charges.

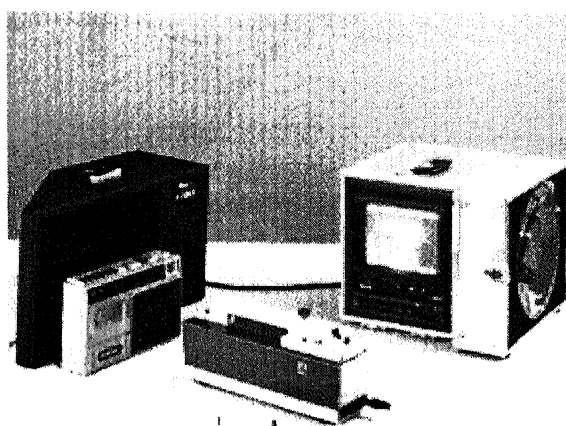


Plate 2.6 Portable X-ray kit

Criteria	Specifications
Dimensions	X-ray source : 380 x 320 x 350 X-ray Screen: 300 x 420 x 600 X-ray Generator : 540 x 400 x 270
Weight	X-Ray generator: 2.0 kgs with battery. Computer system : 9.0 kgs

Table 2.6 Specifications of portable x-ray kit

### E. Electronic Stethoscope

Electronic stethoscope is for the detection of mechanical run back timers and electronic timing systems in improvised explosive devices. The portable, battery operated kit comprises a contact sensor, a non-contact sensor, a control unit/amplifier with shoulder strap and noise suppressing headphones. The sensitivity of both sensors can be optimized by adjustment of the gain and

frequency response. The non-contact sensor, which operates on a Doppler shift principle, is effective through brickwork, wood and plastic. The kit is shockproof and splash resistant and the lightweight electronic control unit can be shoulder or belt mounted.



**Plate 2.7 Electronic Stethoscope**

**Dimension :** 480 x 380 x 200

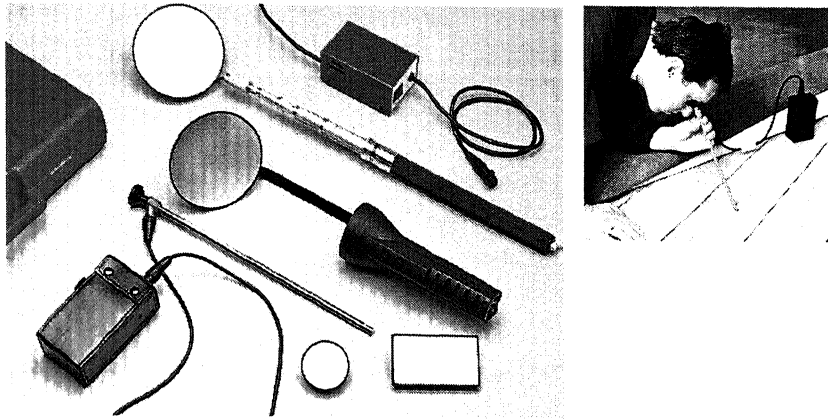
#### **F. Visual Search Kit**

The kit includes a side viewing endoscope for searching inaccessible areas through a gap of 10mm diameter. A 10W halogen lamp in the tip of the endoscope provides bright illumination and enables inspections to be made over distances of up to 1.5m. Power for the endoscope is supplied from a secondary power socket in the fluorescent handlamp included with the kit.

Search mirrors include a long telescopic model that extends to 1400mm for inspecting inaccessible areas in and above containers, for example, and a short fixed length model which is ideal for room searches. Both can be fitted with the range of interchangeable mirror heads supplied. The kit also contains a fluorescent hand lamp to provide a wide area working light and two right angle torches with belt clips.

A selection of miniature mirrors and light probes and illuminated magnifiers are included to assist in the internal inspection of suspect packages and containers with minimal disturbance. Mirrors sizes range from 4.5mm in diameter.

The kit is supplied in a protective foam lined carrying case complete with batteries and replacement lamps.



**Plate 2.8 Visual Search Kit**

**Dimension:** Visual search kit: 820 x 520 x 230

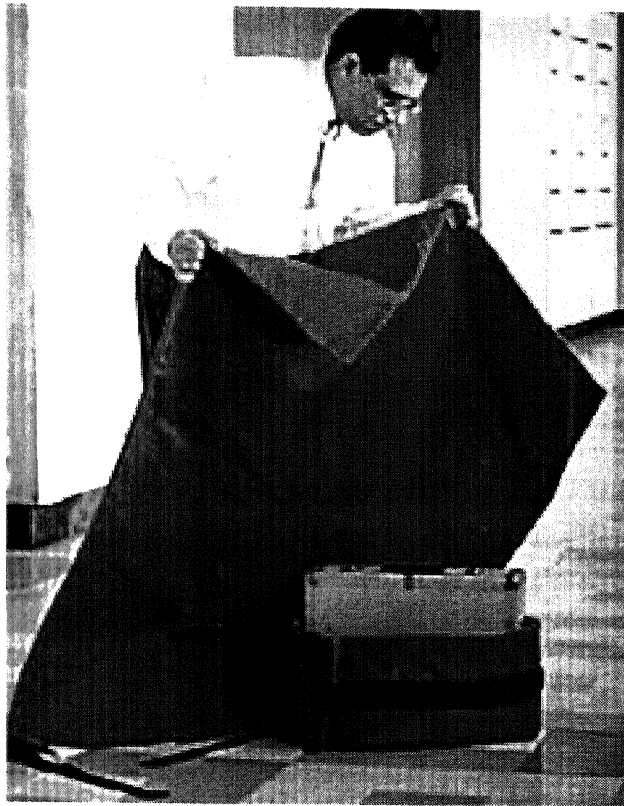
Optical search kit: 540 x 400 x 150

Charger: 115 x 215 x 60

### **G. Bomb Blankets<sup>3</sup>**

Two bomb blankets for use in public areas to suppress the blast fragmentation that causes most damage and injuries. Each blanket is used in conjunction with a blast containment ring (supplied) which is placed on its edge around the explosive device. The blanket is then placed over the containment ring and bomb. The ring directs the force of the blast upwards into the blanket which contains most of the fragments created by the explosion. Two or more containment rings and blankets can be used to suppress larger explosive devices. The multiple layer ballistic filler material is enclosed in a waterproof cover which is fitted with lifting straps and clearly marked DANGER. Both blanket and containment ring fold into a compact, easily carried bag. It is available in two sizes and two threat levels.





**Plate 2.9 Bomb blankets**

**Dimension:** 800 x 560 x 460

#### **H. Bomb Suits<sup>4</sup>**

The suit is constructed from Kevlar® with an outer anti-static cover of 50/50 Nomex/Kevlar and comprises of a jacket, crotch less trousers, groin cup and rigid ballistic panels. The design of the suit is based on the results of extensive tests carried out by the US Department of Defense and effectively counters the four main threats faced by IED/EOD disposal technicians of fragmentation, overpressure, impact and heat.

Salient Points:

- **Fragmentation:** The greatest threat to the IED technician arises from fragments emitted from the bomb and other objects in the surrounding area which can enter the body at supersonic speeds. The lightweight, removable, composite ballistic panels fitted to the suit protect the upper torso, shoulders, neck, arms and legs while maintaining lightness and maneuverability. In addition, the suit is supplied with rigid ballistic panels

to provide added protection to the chest, lower abdomen and groin areas. These have been tested at speeds of up to 1667m/s.



**Plate 2.10 Bomb suit**

- **Heat:** The outer material is constructed from flame retardant Nomex/Kevlar® mix which protects the user against burns.
- **Overpressure:** The pressure wave from a blast can cause severe damage to the lungs, eardrums and cause trauma in other body areas. The design of the suit is such that both sets of ballistic panels limit the effects of the overpressure on the body while the collar completely encloses the neck area and overlaps the helmet.
- **Impact:** The impact of the blast on the body can cause differential acceleration between the head and torso which can break the neck and cause damage to the spine. The suit is fitted with an articulated spine protector while the raised suit collar overlapping the helmet limits the differential acceleration between body and head.
- **Helmet:** The helmet, which offers protection against fragments with velocities of over 683m/s, is made of a lightweight, high strength, fiber and weighs only 3.6kgs with visor (2.7kgs without visor). The ergonomic design allows ease of movement and good visibility without neck strain.

The visors' fully laminated acrylic and polycarbonate construction enhances its margin of safety against multiple fragment hits. The visor provides clear undistorted vision and is also removable.

The helmet incorporates MIL-SPEC microphone and speakers and a forced air ventilation system. The battery pack provides up to 5 hours of continuous operation of the ventilation system and uses standard 9V batteries.

All wiring in both the suit and the helmet, controlling the ventilation system, is incorporated within the suit itself to eliminate the danger of snagging.

- **Cooling System:** For use in hot environments an optional cooling system is available. This is worn under the suit and consists of a Nomex body suit with a capillary tube network stitched into it. This is connected to a 2 litre water reservoir and pump that circulates ice water around the body. The cooling rate is adjustable so that a comfortable working temperature can be maintained.
- **Communication systems:** Two systems are available which are compatible with the speakers and microphone fitted to the helmet, as standard.

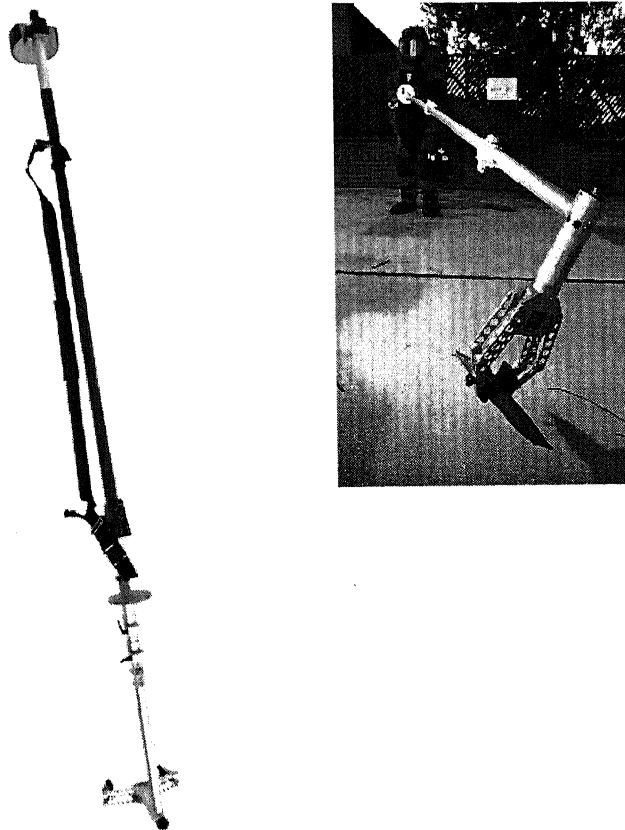
The hardwire system is a compact unit and can be used with most standard reels of two wire firing cable without causing distortion. It is supplied with a headset and microphone for use by a second party and avoids the need for a 'push to talk' type system. A full duplex, wireless system is also available that features a very low level of RF radiation in transmission, to minimize the risk of activating IED's at the device, and a very sensitive receiver ensuring that the second party can always be heard. The user has the option of switching off the transmitter when he reaches a device while still being able to receive incoming signals. The user can also hear his own voice at a reduced level so that he is conscious of the signal being received by the second party.

Component	Weight
Helmet With Visor	3.6 Kg (8.0 lbs)
Full Jacket With Sleeves And Inserts	12.8 Kg (28.16 lbs)
Trouser With Full Rear Leg Protection	15.0 Kg (33.0 lbs)

**Table 2.7 Specifications of bomb suit components**

### **I. Manipulator Arm**

Manipulator arm allows the users to work with dangerous materials while maintaining a safety stand off distance. It has a unique break away tip that allows the user to work with greater safety. The robotic claw of the hot stick system enables attachment to IEDs ranging in shape and material. A response technician can then reel in the suspect package from a safer and distant location.



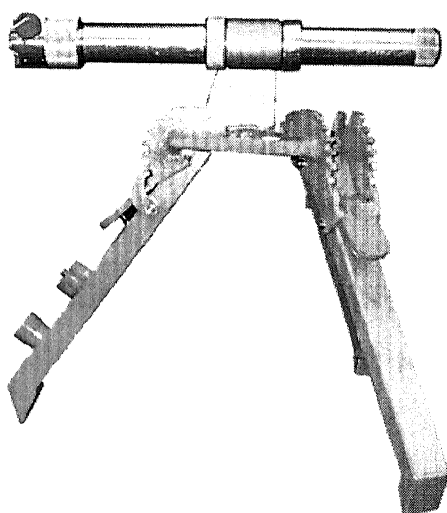
**Plate 2.11 Manipulator Arm**

Component	Length
Collapsed with break away tip	249cm
With break away tip removed	197cm
Extended with break away tip	475cm

**Table 2.8 Specifications of Manipulator arm**

## I. Disruptor

The IED disruptor is designed to penetrate thin walled improvised explosive devices (IED) with a low probability of causing detonation. The equipment is well proven and in service around the world. This is a multi-shot device capable of many firings without sustaining distortion to the main body.



**Plate 2.12 IED Disruptor**

Item	Specifications
Dims(l×w×d)	125×65×47
Weight:	
Disruptor assembled:	1.5kgs
Disruptor in case:	5.75kgs
Stand:	7.40kgs
Dimensions:	
Length of disruptor:	307mm
Transit case (L×w×d):	360×255×98mm
Stand (folded):	760×230×75mm

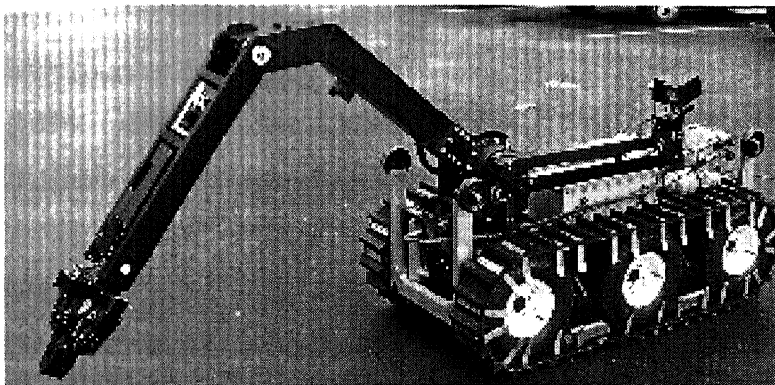
**Table 2.9 Specifications of IED disruptor**

## J. Remote Operated Vehicle (ROV)

The MR-5 is a mobile robot that is remotely operated and very simple to use and operate. It is particularly well-suited as a:

- Hazardous duty robot (hazmat robot)
- EOD robot (explosive ordnance disposal robot)
- Bomb disposal robot (bomb robot)
- IEDD robot (Improvised Explosive Device Disposal robot)
- Surveillance robot
- SWAT robot (special weapons and tactics robot)

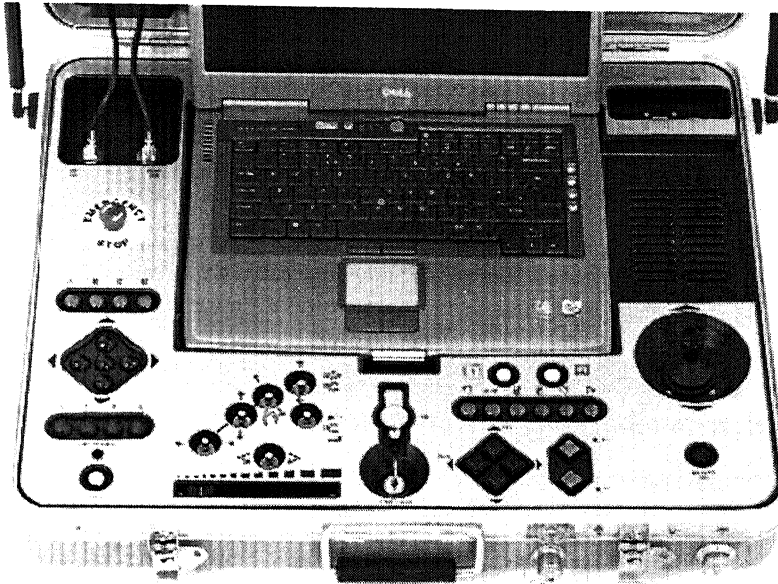
The MR-5 mobile robot is a new generation of hazardous duty robots. It provides excellent precision and dexterity. The MR-5 mobile robot is the medium size of WM Robots' MR series. Police, Military, ERT, Fire, Nuclear, and other Hazardous Response personnel can utilize the multi-purpose MR-5 mobile robot. MR-5 mobile robots could be used for surveillance, reconnaissance, handling of hazardous items, manipulation of suspected packages, neutralizing and handling such items as Improvised Explosive Devices (IEDs), Hazardous Chemicals, and Radioactive Materials.



**Plate 2.13 MR-5, Remote Operated Vehicle**

The MR-5 mobile robot is an all-weather all-terrain mobile robot for indoor (buildings, public institutions, airports, homes, etc.) and outdoor environments (terrain cluttered with obstacles, ditches, gravel, snow, mud, etc.). MR-5 mobile robots are based on latest robotic and computer technologies for hazardous environment operations. This MR-5 mobile robot is remotely controlled, and consists of a robust platform, a dexterous robot arm, operator

control station, communication links, and a variety of operational tools and accessories.



**Plate 2.14 ROV Controller**

Special features of the MR-5 Mobile Robot: quick-removable tracks, quick-removable articulated wheels in front and back for better stability on stairs and slopes, precise independent joint control, long reach, high payload, and expandable to autonomous navigation.

**Overall dimension of Robot:** 1700 x 900

**Overall dimension of Controller trolley:** 600 x 400

#### **K. Miscellaneous Items**

- Small Refrigerator for preparing ice for the bomb suit
- First Aid kit
- Maintenance and repairing kits for the equipments
- Extra batteries, replacements for robot, etc.
- Communication equipments for e.g. walkie-talkies, etc.
- Gas Masks
- Jackets for rainy conditions

## **2.5 RESEARCH DIRECTION - NEED STATEMENT (REVISED)**

**Design and develop the carrier vehicle for bomb squad to carry all their equipments and the squad.**

### **2.5.1 AIMS AND OBJECTIVES/SPECIFICATIONS**

#### **a) Qualitative Requirements**

The project aim deals with three areas of design of the carrier vehicle: Interior Planning, External styling and Systems. So the requirements for both the aspects, qualitative and quantitative are divided on the same basis.

- **Interiors – Qualitative specifications**

- Comfort: The vehicle is a transport for the squad so it has to be comfortable and luxurious for journeys of 1000 kms or for the shorter journeys from one city to another.
- Functional: As the vehicle is a companion in different environments which the target user undergoes including the Bomb diffusal activity, the interior planning has to facilitate proper functions. These functions comprise of loading and unloading of Bomb diffusal equipments. The vehicle has to also prove as a relaxing area in post-bomb disposal session.
- Ambience: Cool, calm and non-claustrophobic space.

- **Exteriors – Qualitative specifications**

Design of rugged and Mean exteriors: It means that the vehicle should look armored though it is not designed to be one and it should have the identity of a military vehicle but properly stylized.



## b) Quantitative Requirements

- **Interiors – Quantitative specifications**

- Number of persons to be accommodated: 6 squad personnel  
1 guard  
1 driver of the vehicle
- Crew Cabin Should consist of
  - + Seating arrangement for 4 crew members
  - + Sleeping arrangement for 2 crew members
  - + Seating arrangement for 2 extra members
  - + Seating can be made foldable to arrange for extra movement space.
  - + Provision of emergency exit
- Equipments to be accommodated inside the storages

Sr.No.	Item	Quantity
1	Portable Explosive Detector	1
2	Non-Linear Junction Detector	1
3	Mine/Metal detector	1
4	Portable X-Ray kit	1
5	Electronic Stethoscope kit	1
6	Visual Search Kit	2
7	Bomb Blankets	2 sets
8	Bomb suits	2 sets
9	Manipulator Arm	1
10	Water Jet Disruptor	1
11	Remote Operated Vehicle with controller kit	1
12	Refrigerator	1
13	Gas masks and Jackets	6 sets
14	SLR(machineguns) and ammunities	6 sets

**Table 2.10 List of equipments**

- Storage Cabin should consist of
  - + Around 15 nos. boxes of bomb disposal equipments are to be fit in the storage in this cabin.
  - + These boxes should be snapped properly to avoid any harm due to vehicle movement during transit.

- + Proper fixing arrangements for Robot/probe and its control trolley has to be designed and developed
- + Proper arrangements for extra storages for payloads of robot and batteries have to be made.
- + Arrangement for 6 gun rack and other ammunitions
- + Ample nos. of charging points for batteries and chargers
- Should follow all the rules of Ergonomics
- Driver's Cabin
  - + Design of storages of wireless communication and PA systems.Also the music system's storage has to be designed and fabricated,
  - + Proper provision for single gun rack for the guard.
- **Exteriors – Quantitative specifications**
  - Chassis is of 14' long Swaraj Mazda truck
  - This chassis can be extended (for spatial requirements) by 60 % of the centre to centre distance between front and rear wheels.
  - The clear distance of the bottom of the body from ground has to start from centre of the wheel.
  - Lifting and disembarking arrangements for robot has to be made either by ramp-type system or hydraulic lifting and suspensions.
  - Proper arrangements of storage for the personal luggage of the squad and one generator, air-conditioner's compressor and batteries has to be made with hatch openings and locking mechanisms.

### 2.5.2 SCENARIOS

The scenarios are a very important part of study as well as the criteria. These are basically the situations in the life-time of the vehicle and the conditions which it undergoes. These are also the factors which decide the reliability of the design under different conditions. The 4 major scenarios are discussed below.

- **On the Docks**

In this situation, the carrier vehicle will be stationed at the workshop of the Bomb Squad. The normal activities that a vehicle undergoes during that period are: Maintenance of vehicle, Maintenance of Bomb disposal equipments, recharging of batteries of the equipments, repairing task of equipments, trials of the equipments.

- **On the Run**

This is an important situation in which the carrier vehicle undergoes various tests. It shares the best of the moments with the bomb squad as to share the anxiety of reaching to site; feeling of teamwork, strategy decision for the situation, etc. This scenario can be divided into three different parts:

Maintenance of equipments: During the travel, the equipments of bomb diffusal can be kept for recharging and repairing can be done. The vehicle has to safe guard the equipments as well as protect from the vibrations and jerks which are normal in Indian conditions.

Preparations for the site: The situation is when the site is approaching and triggers all the preparations for the bomb detection and disposal. Various preparations like wearing jackets, gas masks, of bomb suits, assembly of various visual search kits, etc. take place inside the vehicle.

Attack by anti-social activists: The arrangement of all the defense and counter-attack are to be made in the vehicle to help the bomb squad defend themselves from the attack. As bomb squad can fail the plans of these anti-social activists, the vehicle becomes the obvious and easy target

for them. This also includes the storage for the arms and ammunitions required for the attack.

- **On site**

This scenario is another important situation in which the vehicle has to be efficient in reducing the activation time of the bomb squad. The internal planning and storage arrangements play an important role in this case. The vehicle has to facilitate the fast movement of the equipments including the remote operated vehicle.

- **Back Home Journey**

A relief time for the vehicle and the travelers in the journey back home (to the headquarters). The vehicle here shares the success or failure of the team. In unfortunate conditions, the vehicle has to carry the dead bodies of the team members!

# Chapter 3

## INFORMATION COLLECTION

### 3.1. INTRODUCTION

After understanding the concentrated need statement and requirements and specifications related to it, the next step involves the study of various Parallel and similar products in the market. It also relates to study of various semiotic codes which can be used to design certain details or parts. Various factors which require research and data collection are:

- **Interior Planning:**
  - Overall demarcation of zones
  - Seating arrangement for the squad
  - Storages
  - Arrangements for Remote operated vehicle and related units
- **Exterior Styling:**
  - Styling and functionality features of luxury vehicles
  - Styling and functionality features of military vehicles
- **Data regarding Ergonomics - a very important factor**

The data is collected for the following products or systems:

- **Semiotic codes studied**
  1. Modular kitchen systems for lighter storage items
  2. 5-Star Hotel kitchen storages for heavy storage items
  3. Jet-Plan lashing eye on ship decks for snap fittings
  4. Large car carriers for snap fittings and ramp arrangements
  5. Indian Railways sleeper coach for seating arrangements
  6. Mobile homes for planning

- **Parallel Products studied**

1. Emergency ambulance of Apollo hospitals
2. Volvo Bus styling
3. Other luxury bus styling and fabrication
4. Military vehicles for styling

### 3.2 SEMIOTIC CODES

These products are basically the products which do not have a relation with the final product but they have certain characteristics which when incorporated in the product can lead to a good design.

#### 3.2.1 MODULAR KITCHEN SYSTEMS

##### 3.2.1.1 Scenario

Indian house kitchen with all sorts of different boxes, spices storages, wide variety of vessels and cutlery, time-taking processes of cooking Indian delicacies.

##### 3.2.1.2 Solution

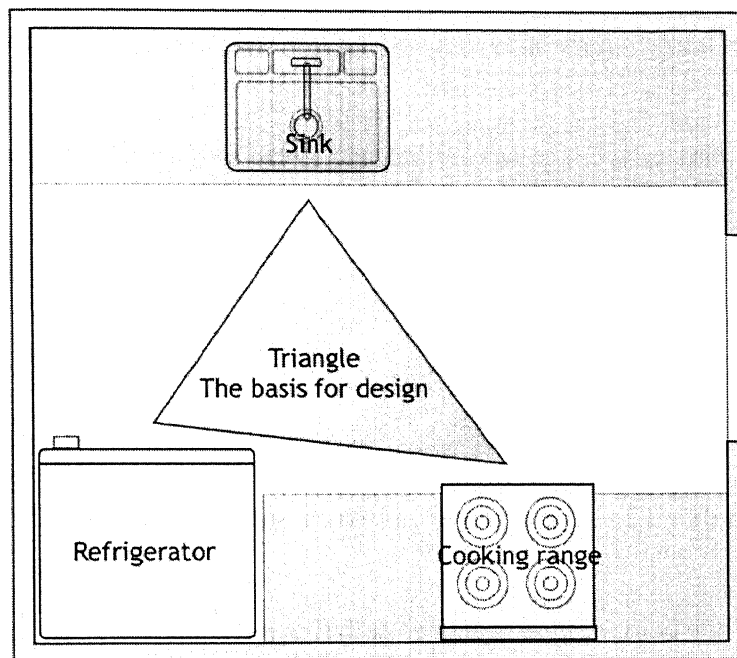
The ideal solutions for kitchens are the modular kitchen systems which are nowadays manufactured by many leading manufacturers. It gives both the options clubbed together i.e., modularity with customization.



**Plate 3.1 Modular Kitchen system in a modern house**

### 3.2.1.3 How it works?

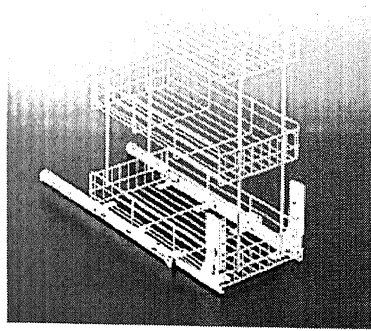
- Shutters and other accessories are pre-fabricated with the custom design in front.
- Every layout is different because of the difference in sites but same modular parts are repeated to attain less cost of manufacturing. The basic planning remains the same of following the triangular interaction between the 3 major parts of the kitchen: sink, refrigerator and cooking range. It basically follows the philosophy of Input-Process-Output. This demarcation and distances are followed on the basis of area available for the kitchen and also the cooking habits.



**Fig. 3.1 Typical layout of a kitchen showing the triangle of work**

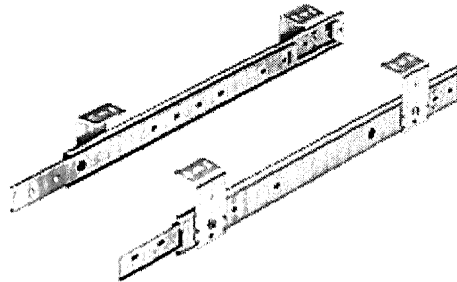
- Material: Integration of MDF, Stainless Steel and stone slabs for work counter. MDF is mainly used for the storage shutters and for overhead storage. S.S is used for the trolleys, drawers for the storage of cutlery and other requirements. S.s does not allow cockroaches to develop inside the cabinets as it does not absorb humidity. Cleaning of stainless steel is easy.





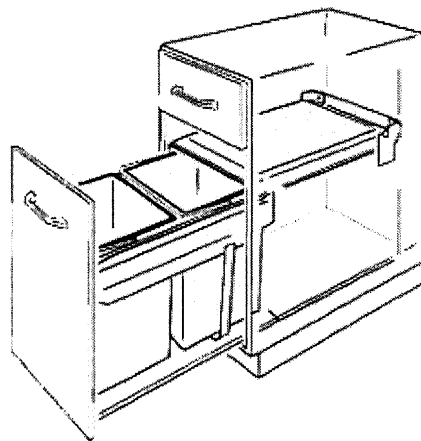
**Plate 3.2 Tray system in kitchen storages**

- Brass handles are used for the shutters to ensure the long life and rough usage pattern.
- The drawers are fixed with heavy channel for easier and smoother usage.



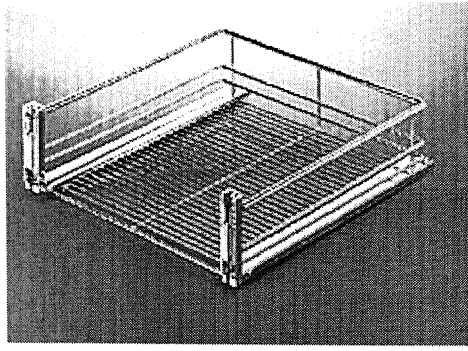
**Plate 3.3 Heavy channels for smoother performance of the drawers and trays**

- The usage pattern of an average Indian female is kept in mind and also the conditions at home while designing.



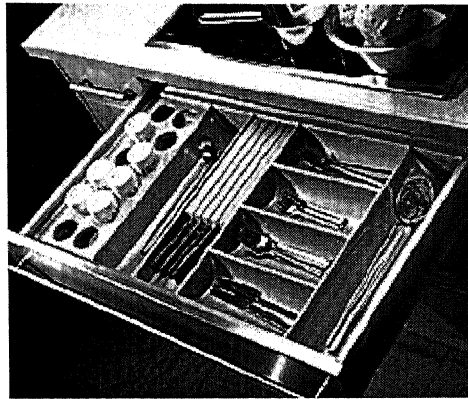
**Plate 3.4 Waste disposal arrangement in a modular kitchen system**

- The storage is designed to take the maximum loading that its volume can take.



**Plate 3.5 Tray in a modular kitchen system**

- Proper racks for different purposes are derived and designed as per the user's requirements i.e. Special racks for bottles, cutlery, etc.



**Plate 3.6 Flexible partitions used in a tray which can be removed as per requirements**

### 3.2.2 SEMIOTIC CODE: HOTEL KITCHEN SYSTEMS

(Case study of **Sun n Sand 5-Star Hotel**, Pune, India)

#### 3.2.2.1 Scenario

The hotel kitchen is a place where the cooking habits are very rugged but still maintenance of quality and cleanliness is an essential requirement. The conditions and movement inside these kitchens is rugged and fast. In all it can be said as the test of any cooking utensil and equipment.

#### 3.2.2.2 Solution

The solution which is used by the 5-star hotels, world over, is the racks made of stainless steel.



**Plate 3.7 5-Star hotel kitchen-note the storage stand in the left end**

- These racks are built-as-per-order and not pre-fabricated or modular.
- Material: Heavy stainless steel. Pipes with brush steel finish. The use of this material suggests the rugged ness and hardships these racks can undergo.
- Stainless steel is used to facilitate long life and also it does not get affected by humidity/water spillage, which is a normal scenario in the kitchen.
- These racks can take amazingly heavy loads.

- Some of the racks have optional heavy castors attached to the legs to facilitate movement/transfer.



**Plate 3.8 Use of stainless steel helps prevention of rodents, insects, ease in cleaning**

- The joinery type used is welding and racks' shelves are fixed type except few of them which facilitate the movement of trays installed. The method used for sliding is not the normal arrangement used for office furniture drawers, instead a much more rugged arrangement used. The arrangement is basically L-angle arrangement without any wheels to facilitate the smooth movement but it protects any accumulation of food particles and thus rodents and insects which thrive on left-over foods.
- Drawback: Some of the racks were facing problem of dents in s.s pipes and because of that dirt gets settled in those crevices.
- Manufacturing time and cost is low as compared to the modular kitchens as these kitchens have specific demands.

### 3.2.3 JET PLANE/CARGO CONTAINERS LASHING EYE ON SHIP DECKS/CARGO AIR PLANES

#### 3.2.3.1 Scenario

Cargo on a ship deck or in cargo airplanes faces the maximum jerks or vibrations.

#### 3.2.3.2 Solution

A simple lashing eye (as shown in picture no.---) is used to keep cargo in place. These lashing eyes are used for wide variety of objects, ranging from a cargo container to fighter jets and helicopters. These lashing eyes are prepaid on the ship decks and cargo air planes' floor. The only part left is to bind the object with the help of cables with those lashing eyes. An arrangement of cables in two axes and in some cases in 3 axes solves all the purpose.

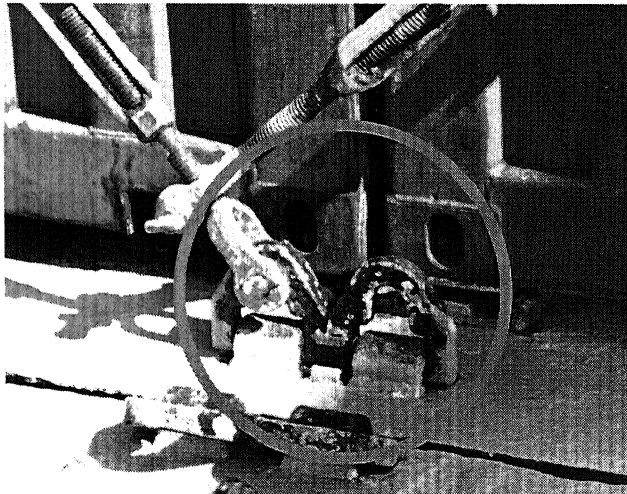


Plate 3.9 Lashing eye for containers

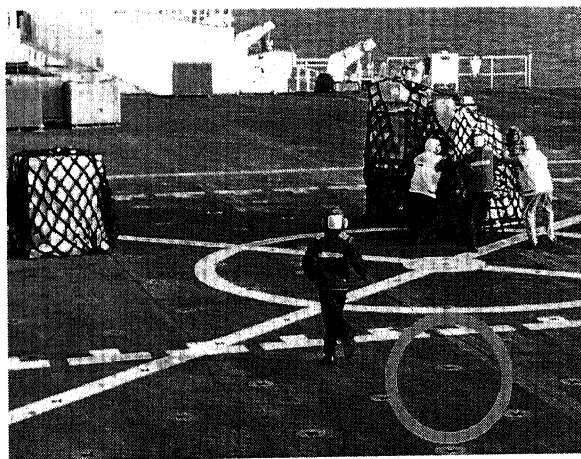
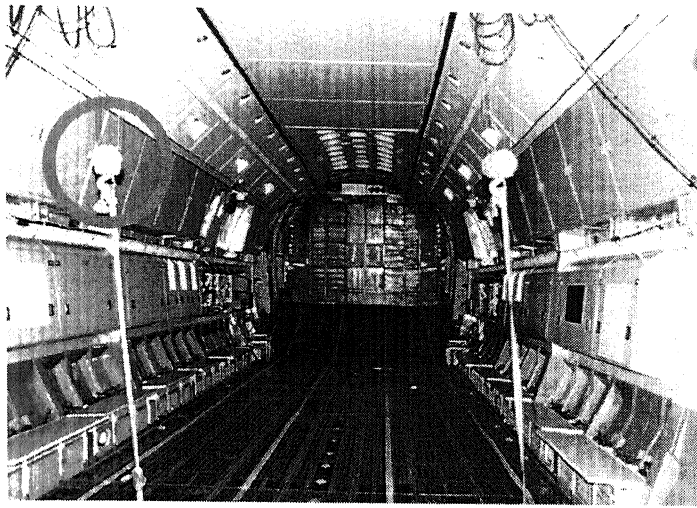


Plate 3.10 Lashing eyes are placed many in numbers on the ship deck



**Plate 3.11 Lashing eye arrangements from ceiling in a cargo plane**

- A simple solution to bind the objects in two or three axes.
- A perfect design to even carry the heaviest and costliest of the machines as the centre of gravity of those machines takes care in this method. It works on binding the movement of an object in three axes as there are only three axes of freedom an object can have at maximum conditions.
- The reuse is possible and for a longer term too.
- A good solution to bind the remote operated vehicle and its controller trolley.

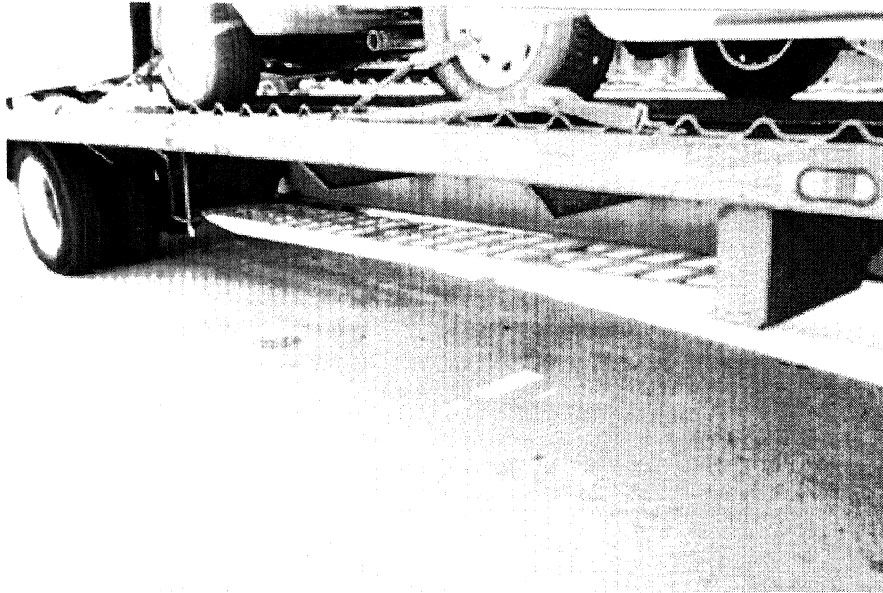
### **3.2.4. LARGE CAR CARRIERS (TRAILERS)**

#### **3.2.4.1 Scenario**

The cars from the manufacturing plants are transported on large car carriers or trailers to the showrooms and storage areas. These car trailers can carry around 6-8 cars at a time and travel in the tough Indian conditions. Any dents or scratches on car's body during the transportation can render that car back to the manufacturing unit.

#### **3.2.4.2 Solution**

The trailers have a simple snap arrangement of blocking the cars in two axes. The car's weight helps it to block its movement in the third axis. These snap arrangements are either the lashing eye type arrangement or the road on a hinge which gets locked in the upright position in an angle, blocking the tire's movement.



**Plate 3.12 Attached car to the trailer**

### **3.2.5. SLEEPER COACH BIRTHS OF INDIAN RAILWAYS**

#### **3.2.5.1 Scenario**

A family of 4 is traveling; on the other hand a group of 8 is traveling in the same coach. Numbers of passengers in Indian railways are more than the trains available.

#### **3.2.5.2 Solution**

The solution for the layout of the seats in Indian railways is to form a group of seats and thus repeat the cell. This way the usage of the floor space available is perfect thus increasing the number of seats possible in a fixed size coach. A group of 8 is formed in which half of them face the other half with a 2' passage in between.

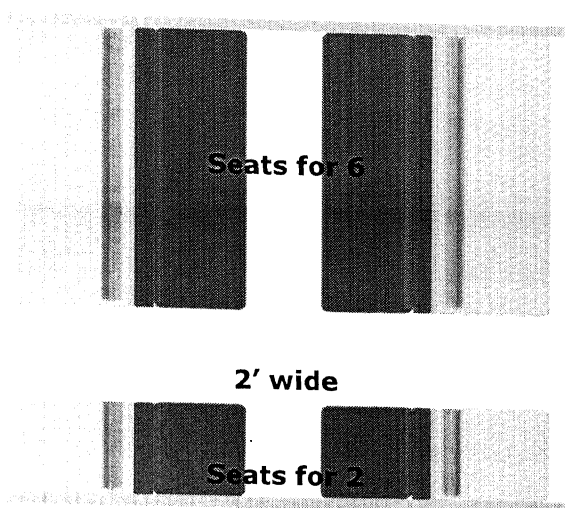


Fig. 3.2 Typical seating arrangement in railway coaches



Plate 3.13 Sleeper coach of Indian railways

गुरुपुत्रोत्तम काशीनाथ केलकर पुस्तकालय  
भारतीय प्रौद्योगिकी संस्थान कानपुर  
भवापि क्र० A 149250.....

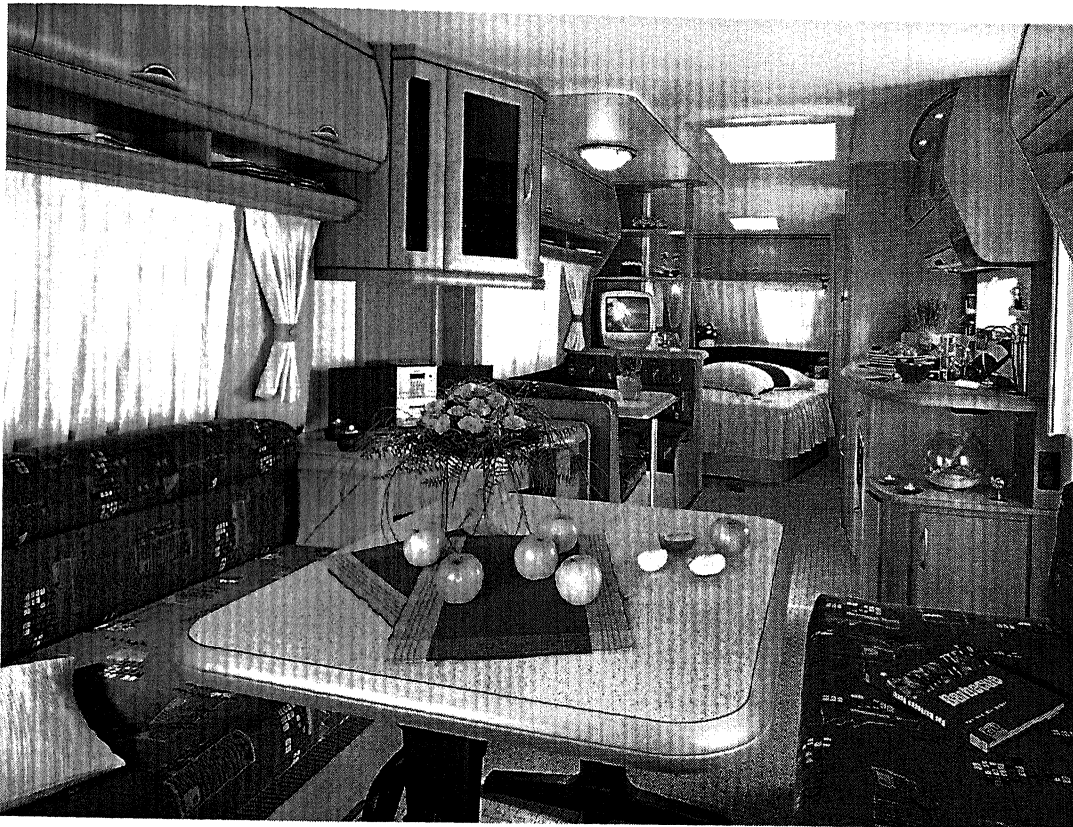


### 3.2.6. MOBILE HOMES (MOTOR HOMES)

#### 3.2.6.1 Scenario

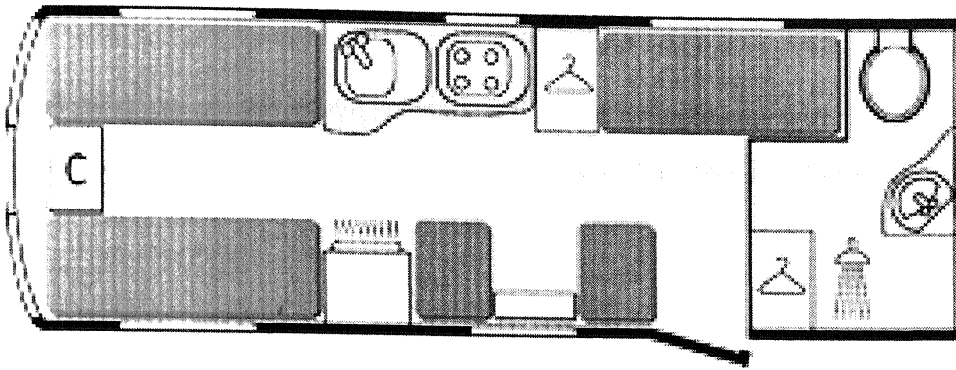
The house-on-wheels incorporates all the comforts of the house. It has a living room, beds to sleep, a small pantry and a toilet. The joineries and construction work of the various components face the vibrations and jerks of the road but still withstand the test of time.

#### 3.2.6.2 Solution



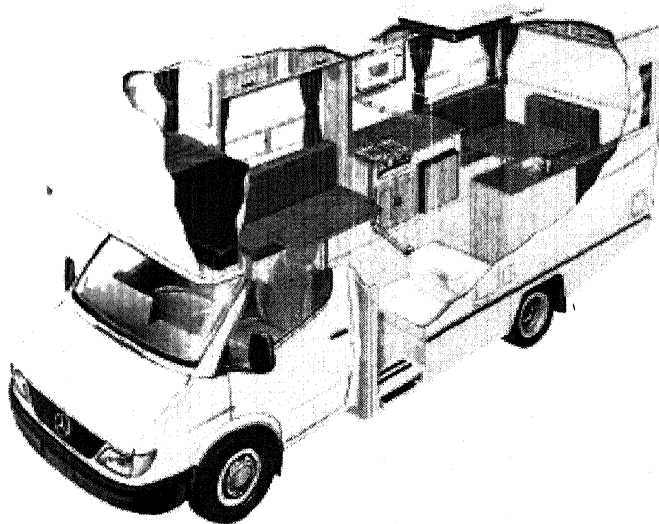
**Plate 3.14 View inside a Mobile home**

- The mobile houses are planned to use the maximum of the space and waste as little as possible. A small pantry drawer can house more than possible in a normal kitchen drawer with kinetic arrangements and partitions.



**Plate 3.15 Typical layout inside a Mobile home**

- It also has the protection arrangements for the bottles, cutlery and glass wares from the vibrations and jerks.
- Various materials used are wood and steel with some components of plastic. Though wood, in any form, is not a good choice as a material where there are many moving parts as the joints fail in wood during movements.



**Plate 3.16 Sectional view of a mobile home**

- The arrangement of various storages are done in all the furniture for e.g. a bed, a sofa set can house the beddings and pillows in it.
- Ample number of skylights and windows are provided for the natural light to come in.
- These mobile homes are usually add-on vehicles to the small trucks and come in a variety of sizes. These sizes are dependent on the State rules and the specifications given by the client.

### 3.3 PARALLEL PRODUCTS

Parallel products are the products which have great resemblance with the Bomb squad carrier vehicle and thus study of all its parts can contribute to the betterment of the design.

#### 3.3.1. FIELD STUDY - PARALLEL PRODUCT: EMERGENCY AMBULANCE

(Case study of *Ambulance 1066, Jehangir (Apollo) Hospitals, Pune, India*)

##### 3.3.1.1 Scenario

An emergency call was placed in the Emergency ward of the Apollo Hospitals regarding an aged man who just is going under a heart attack! The same emergency condition is prevalent in case of suicide cases, fire in a building, bomb explosion, road accidents and many other situations. These emergency cases are tackled by the hospitals with round-the-clock facility for treating such cases. The critical time is the transportation time for the patient, from the site of calamity to the hospital's emergency ward!!

##### 3.3.1.2 Solution

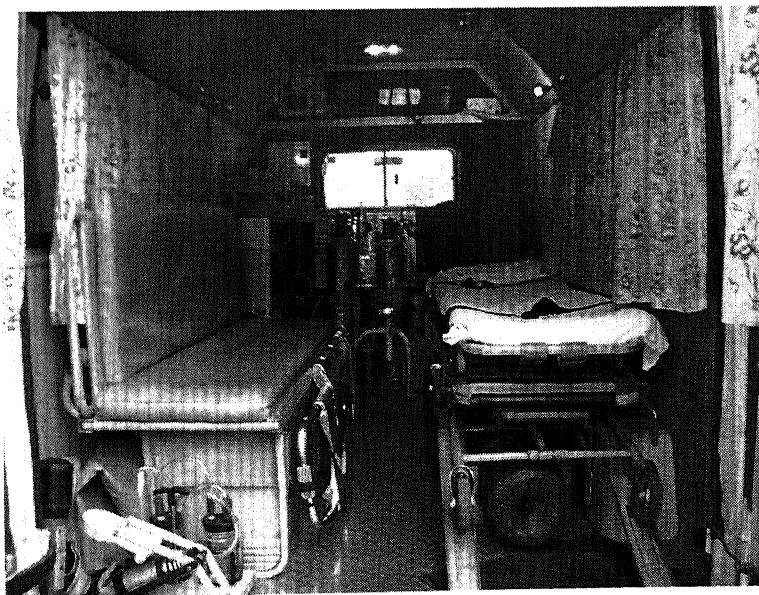


Plate 3.17 Ambulance 1066 in front of the emergency ward

The Ambulance 1066 is the emergency ambulance of Apollo Hospitals which tackles the emergency cases only in the zone of radius of half-an hour traveling time. The 1066 is the international toll-free number for emergency cases.

### 3.3.1.2 Introduction

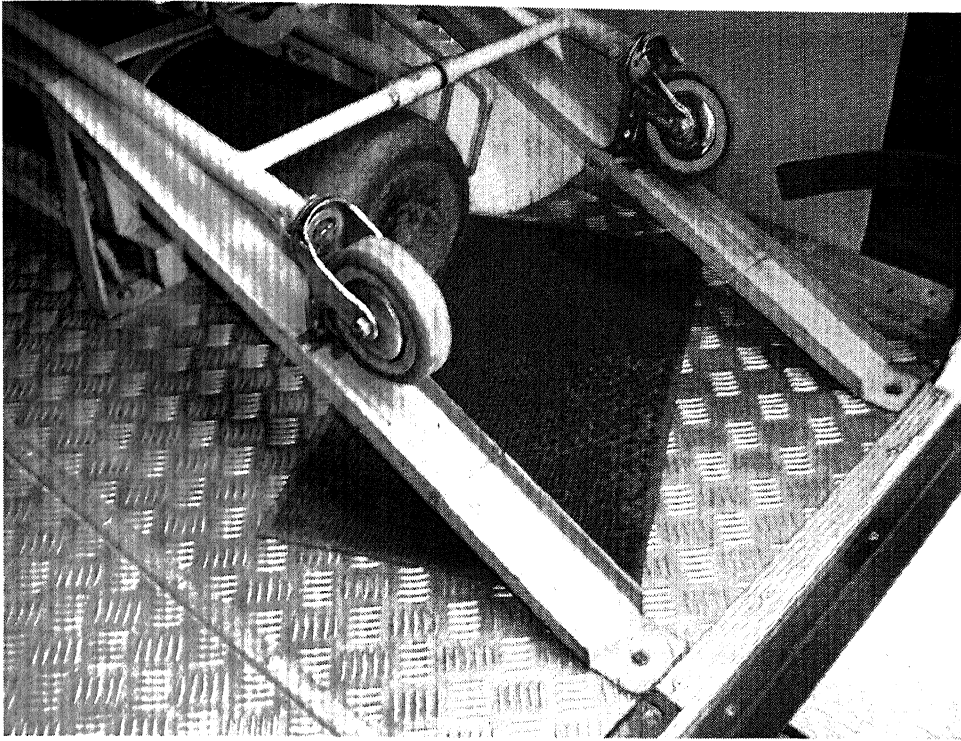
- The ambulance is the modified form of Traveler model manufactured by Tempo, a company that specializes in ambulances and school buses.
- This ambulance runs as per the conditions of the patient but it has faced really fast moving conditions in case of emergency of accidents.
- The ambulance carries one driver, one guard, one back staff, one doctor, in all 4 member crew. There is an extra seat for one relative of the patient and the stretcher for the patient himself.
- The interior plan of the ambulance facilitates the easy and fast entry and exit of the patient with all the emergency equipments required. The entry part has stretcher on one side and seats on the other side. The space near the driver's cabin has the seat for the doctor and the storage containing all the emergency medicines, injections and equipments. This area also has the oxygen cylinders attached (with the help of clamps) to the back wall of the driver's cabin. Ceiling height of the back cabin is just 6 feet.



**Plate 3.18 View from the rear side of the ambulance**

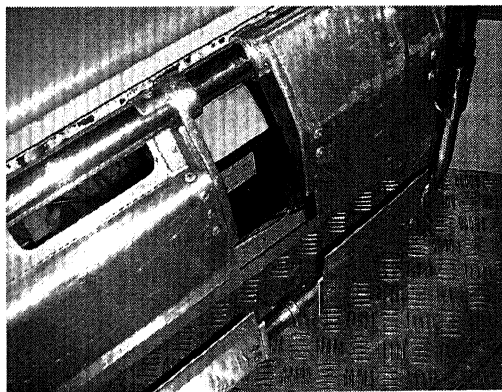
### 3.3.1.3 Details

1. Ramp for stretcher: The stretcher gets folded as soon as it goes on the ramp and unfolds as it descends. The ramp is made of C channels.



**Plate 3.19 Stretcher ramp detail, the wheels of stretcher rest on the C-channel ramp**

2. Tower bolts are used for locking 4 legs of the stretcher.
3. One of the stretcher can be broken into 2 parts which can carry a patient with spinal injury or injury at the back. These injuries may cause special nervous problems near medulla oblongata if the patient is not handled properly at the time of transportation.



**Plate 3.20 Special stretcher**

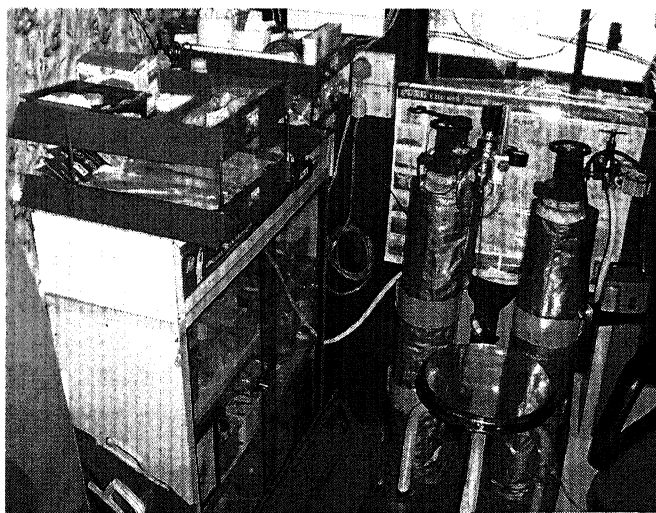
### 3.3.1.4 SWOT ANALYSIS

#### Strengths

- The ambulance carries lots of equipments for emergency situations.
- Patient handling is properly taken care of.
- The chassis of Tempo traveler supports the loading and speeds.
- Driver is well trained for all the conditions of emergency and speed of vehicle depends on the condition of the patient.
- Proper seating areas for doctor, assistant, nurse and one or two close relatives of the patient are provided.
- Proper arrangement for hanging saline bottles.
- Proper arrangement for emergency lights.
- Foam or soft cushion is good for the less height this vehicle has. It is also the safety for the travelers.
- Floor and seating finishes are good for rough usages and conditions like blood spillage and other fluid spillages.

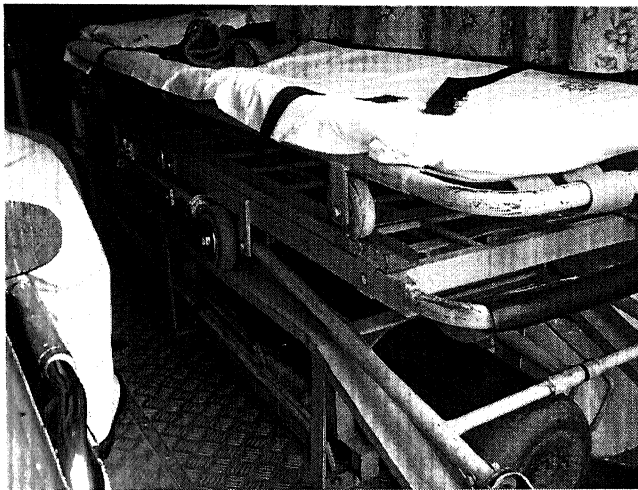
#### Weaknesses

- No air conditioning has been provided though it is the best for the patient in such cases.
- Clear height is only six feet which is less but still the fans are fixed.
- Storages are not proper and made by the local carpenter and were not provided prefabricated.



**Plate 3.21 Storage system in the ambulance**

- In case of design the ambulance could have handled more storage so there is still wastage of space.
- Stored equipments are not categorized properly, may be because of the type of storage provided.
- This ambulance is unfit for long travels.
- Cleaning is a problem because of different corners.
- Color inside the ambulance is too dark and should be made much lighter and lively.
- Passage space is too less which is also not the clear space.



**Plate 3.22 Stretcher arrangement in the ambulance**

### **Opportunities**

- Storage can be well designed in some other materials to avoid entry of rodents and other insects.
- Fixing of stool can be made proper rather than tying it with the cylinders.
- Storage can be made removable type to help in maintenance.
- Some of the equipments which are required near the patient can be kept nearby him for ex. ventilator, ECG should at the top.

### **Threats**

- If cleaning is not done properly then insects might seep in behind storages.
- Hard to clean under the stretcher and seating



- Storages in wood might cultivate cracks due to the regular movement of the vehicle and thus the joints will fail in future.

### 3.3.2 FIELD STUDY - VOLVO BUSES (INTERCITY BUSES)

(Case study of *Neeta Volvo*, *Neeta tours and travels*, Mumbai, India)

#### 3.3.2.1 Scenario

Luxuries, comfort, speed and class is what today's traveler demands for in his/her carrier. Not only are the other factors important but also the aesthetics of the vehicle.

#### 3.3.2.2 Solution

The Volvo luxury coaches in India have become very popular since the introduction of better highways and government policies regarding the travel. These coaches are plying especially on the route of Mumbai to Pune in large numbers because of the type of travelers and road conditions.



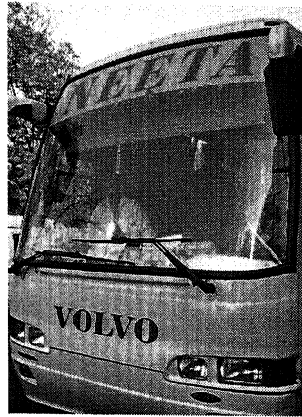
**Plate 3.23 Volvo Bus**

#### 3.3.2.3 Introduction and features

- The Volvo buses have an imported engine of Volvo and the bus body is manufacture in Hoskote, India.
- These buses are for the journeys as long as 1000 kms but are more preferred for shorter journeys, about 200-300 kms.



- The area of glass on the exterior is almost  $\frac{1}{3}^{\text{rd}}$  as compared to the area of metal which is unlike any other coaches built in India. There are large glass panels and rear-view mirrors with integrated close-quarter mirrors to ensure good all-round visibility.



**Plate 3.24 Front face of the Volvo bus**

- The passenger seats are raised as compared to the driver's area seats. All the seats offer a high level of comfort, are reclinable and feature velour upholstery, head restraints and foot-supports, as well as a choice of three-point or two-point seat belts. Booster cushions are available for children.



**Plate 3.25 Seating arrangement inside the Volvo bus**

- The coaches are rolled out of manufacturing plant with automatic doors, Grammer seats and air-conditioning units.
- The Volvo coaches are fitted with air suspensions which reduce the vibrations and jerks.
- The driver's compartment is spacious, ergonomically designed and pleasantly sound insulated.



**Plate 3.26 Driver's cabin**

- An entirely new electronically controlled ventilation system provides a pleasant climate.
- High quality and a long service life: The frame is of a precision-welded box-section construction and it is made of stainless steel, as are the exhaust system and the body.

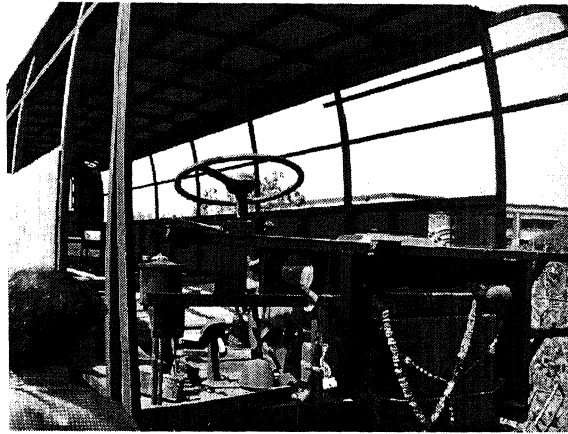
### **3.3.3 PARALLEL PRODUCT: LUXURY BUSES (INTERCITY BUSES)**

(Case study of *Indore Bus coach Manufacturers*, Pune-Nashik Road, India)

This study concentrates to the manufacturing or fabrication techniques prevalent in the bus industry. The idea was to understand the structural members and fabrication process so that design of the details for the Bomb Squad's vehicle can be done in more interactive manner. It is also to judge what is wrong and right in the method of fabrication and give the design the full justice.

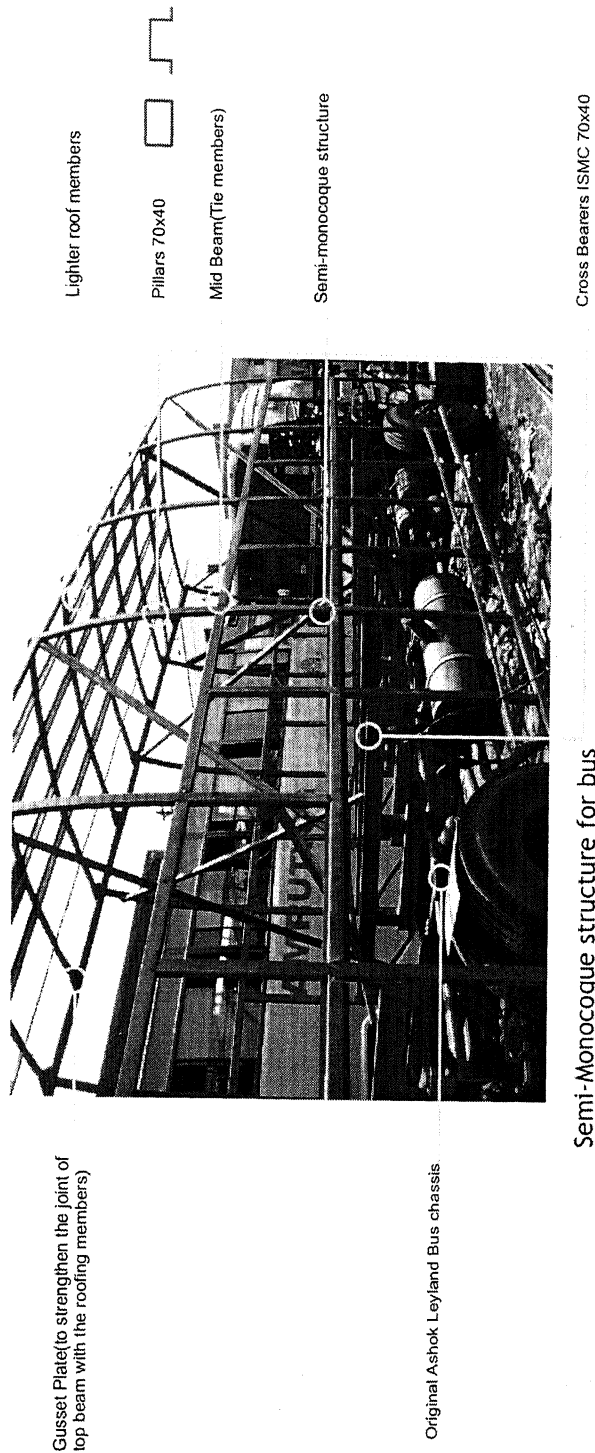
#### **3.3.3.1 Details**

- The most common type of chassis used is of Ashok Leyland bus chassis. The reason for using this chassis is that it comes without any factory built body (driver's cabin) and thus allows more freedom for changes.



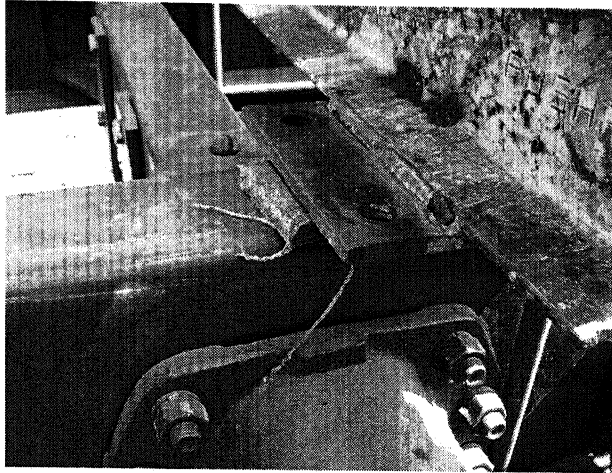
**Plate 3.27 Ashok Leyland chassis**

- The buses body is built as semi-monocoque structure and not Integral structure in Indore Coach Manufacturers. Semi-monocoque structure method has a pre-built (factory built) chassis on which the structure is constructed. On the other hand, integral coach involves the integration of engine with the main bus body. There is no chassis in Integral coach method.
- The rear part of the bus structure is divided into 8-9 parts and these parts decide the placement of cross-bearers (ISMC 70x40). The cross bearers then run on the sides as pillars and position of these pillars sometimes depends on the placement of openings i.e. Windows, doors, etc.



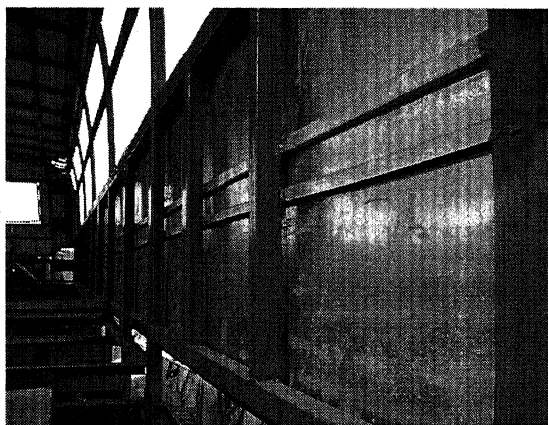
**Plate 3.28 Semi-Monocoque structure for bus**

- These cross bearers are bolted to the main chassis and spot welded for assurance with Balatta packing in between. Balatta is actually the belt from flour mill's machine and acts as a good contact breaker of metal to metal. It also helps in cushioning effect.



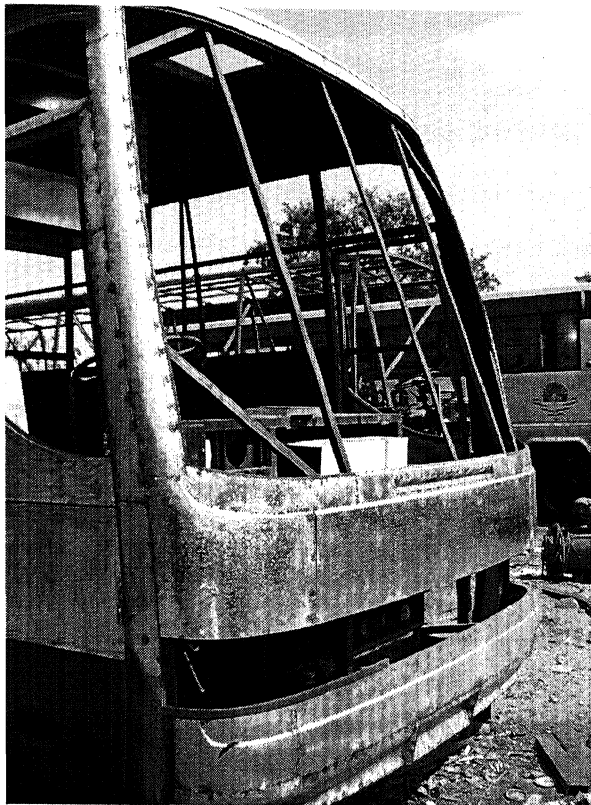
**Plate 3.29 Detail of joinery of chassis with the upper body**

- As the trend of bigger and wider glass windows is in effect, the pillars and cross bearers are placed at much larger center-to-center distance. Usually it is maintained between 2'-0" to 2'-6".
- The normal overhang beyond the rear wheel is not more than 60% of the c/c distance between the two wheels. Even the maximum overhand does not pose any problem for the maneuvering of vehicle on Indian roads.
- Some of the materials which are used for bus body are G.I. Sheet, FRP, steel, aluminum, etc. These sheets are used either in the form of panels i.e. 8'x4' or in the form of one piece sheet. The thickness varies from 1.5mm to 3mm, as per the material.



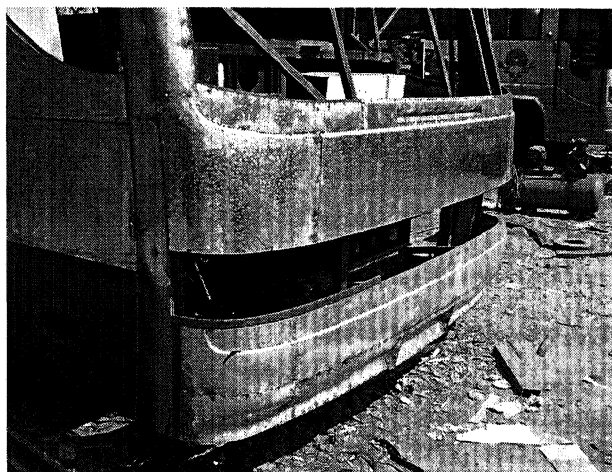
**Plate 3.30 GI sheet paneling on the structural members**

- The buses being built were actually the copy of much popular bus body designs i.e. Volvo and Sutlej.



**Plate 3.31 Front face is same as the Volvo bus design**

- The process of giving different shapes, curves or contours to the bus body involves fixing of sheet metal to the already shaped structure and then cutting at places where protrusion or deformation is taking place.

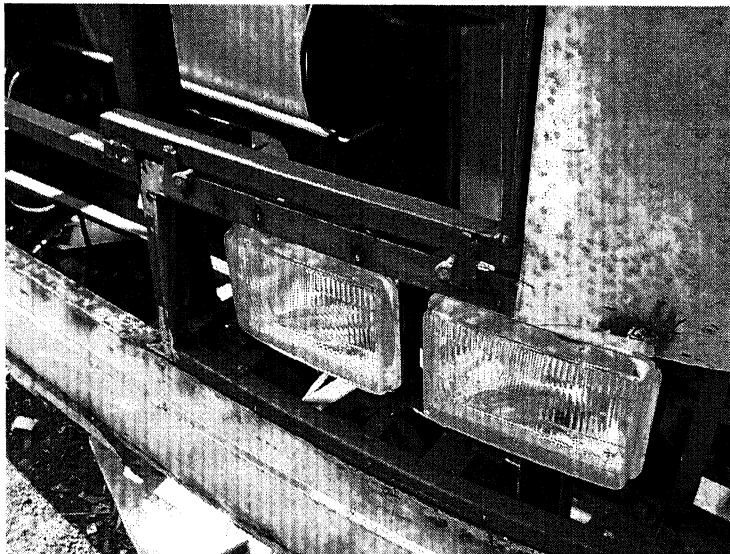


**Plate 3.32 Lower front face of the bus**

- The joinery type used for sheets and the bus structure is welding or screws in Indore Coach Mfrs. The best method is to use Blind rivets. These blind rivets

give the freedom of bus body maintenance as in case of partial damage in a mishap the sheet can be simply changed/replaced by knocking off the rivets. But in case of welding, the sheet has to be cut and then rework on the structure has to be done.

- Before spray painting of the bus body, the welding joints are made stronger and also grind to give smoother finish. Later on, Putty (Lambi) is applied. This putty is sometimes used to hide the mistakes in construction and applied heavily (sometimes double the thickness of G.I. Sheet used as cover!). This later on, poses threats of chipping off in case of mishaps or minor dents.
- Luggage compartments are mounted at the back of chassis and also on the sides. Sometimes the chassis is cut in order to increase the space inside the compartment. These compartments are integrated with bus body structure and have aluminum chequered plate finish inside.
- The head lights used are standard ones available in market and a wide variety is available with the light manufacturers in Delhi.



**Plate 3.33 Detail of headlights fixing**

- The base for any flooring in the buses is usually 12mm marine plywood. On the plywood, desired finishes are fixed for eg. Aluminium chequered plate, vinyl anti-skid sheets, etc.

### 3.3.4 PARALLEL PRODUCT: MILITARY VEHICLE STYLING

*(A photographic study)*

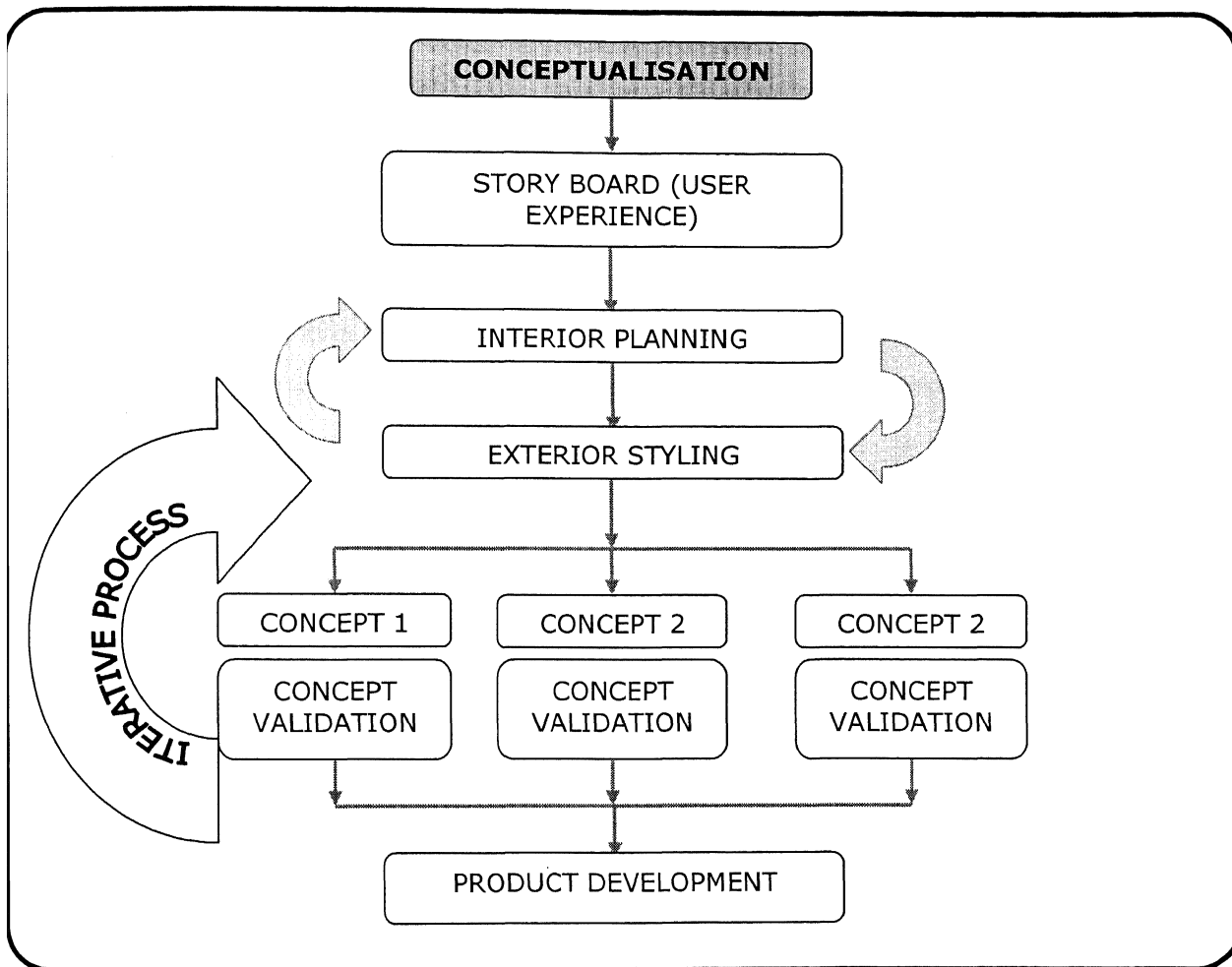






## Chapter 4

# CONCEPTUALISATION



**Fig. 4.1 Conceptualization process**

The steps for conceptualization process are shown in the Fig.4.1. The process depends on three major factors: *User experience*, *Performance of vehicle in different scenarios* and *Practicality of details*.

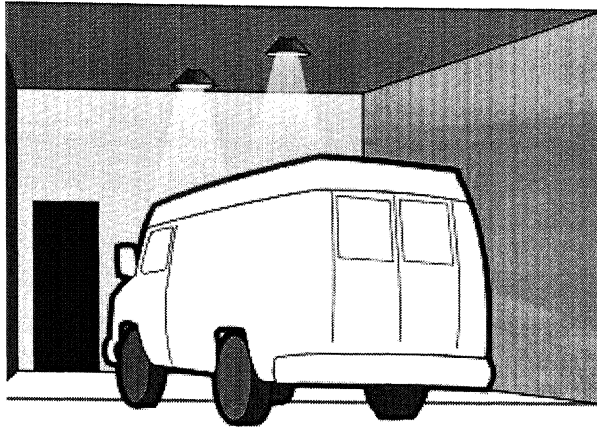
In the process of conceptualization process, there are three areas of concern

1. Interior Planning
2. Exterior styling
3. Detailing

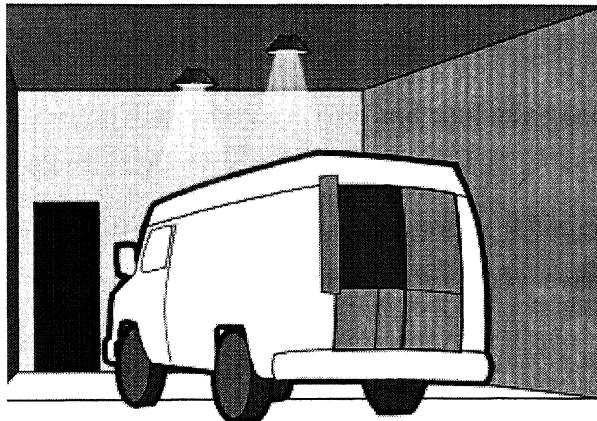
The top two factors are inter-related and inter-dependent i.e., on the basis of changes in interior planning, exterior styling changes and on the basis of exterior function requirement, interior planning may change. So, both the factors are designed at the same time. The steps further involve design directions and selection of the best out of the same. The final step involves the process of detailing of the chosen design direction.

#### **4.1 STORY BOARD**

The story board is an essential part of the conceptualization, especially for the projects where the user is assumed. As in this case too the user is an assumed one, the story board builds the virtual surroundings, experience of the user. This exercise involves me as the first person in the virtual surrounding of Bomb Squad and a part of the Bomb Squad. Prior to this brainstorming, all the study or research is completed to understand the parallel products, semiotic codes and the group of people who can be closer to the Bomb Squad as far as traits are considered. Some of the important factors understood during the virtual tour are as follows.

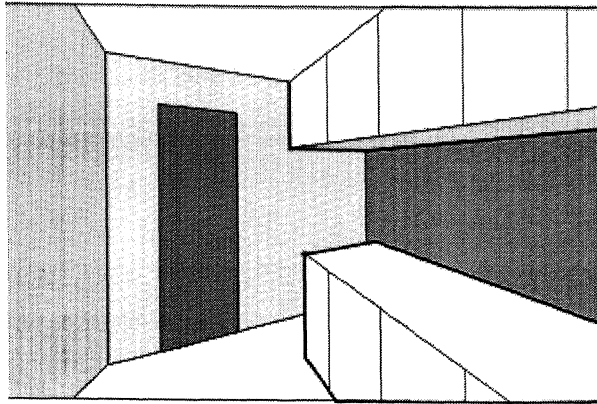
**A. On the Docks**

- Some slogan or graphics on the vehicle (at eye level) which makes the user more patriotic and dutiful.
- Rear door should not be 270 deg. Turn kind of door as closing it from inside will it be a problem.
- Handle at the door should be placed down at hand's reach, according to ergonomics.
- Mid door should be at least 3' wide (maximum the better).
- Walky talkies should be on my left and also other gadgets, near the door.

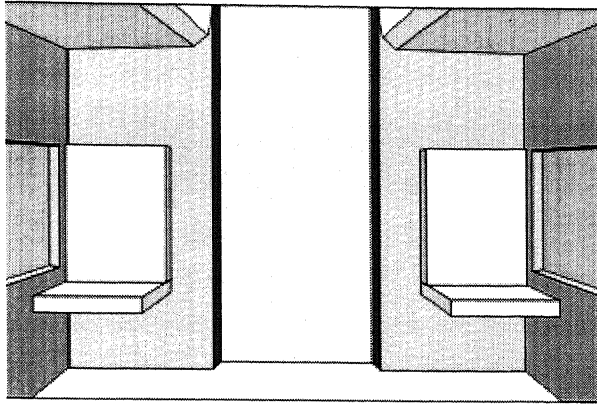
**B. Loading time**

- Doors which give opportunity to operate in 2-3 ways with simple arrangements.
- The door should fulfill the biggest factor of fast movement which is most required for the movement of all the boxes in the vehicle and also the remote operated vehicle. We faced the biggest problem with the ROV as the vehicle took lots of maneuvering before it could be snapped in its place.

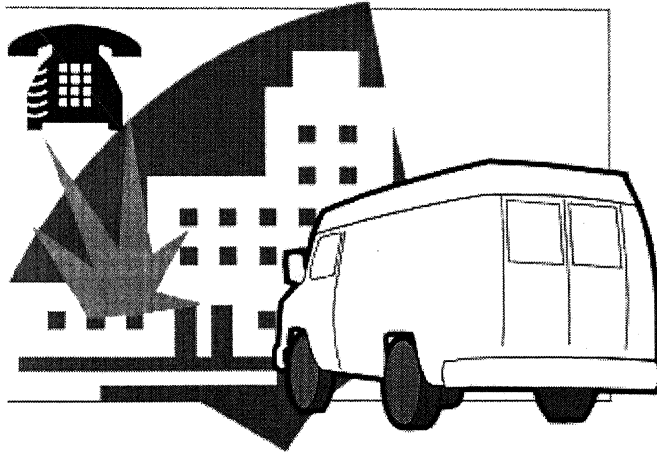
### C. Storage cabin



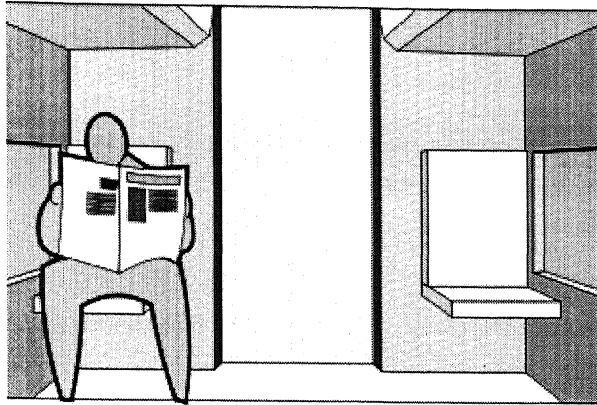
- We were arranging all the equipments inside the storage cabin. The equipments required proper snap arrangement so it doesn't get damaged during the journey.
- We were arranging all the equipments according to the degree of importance and steps of Bomb detection and disposal. Some of the bags like Bomb suits went on the top cabinets as it was the last thing which comes out during the operation.
- Two of my team members were putting all the batteries to the charging pod so that by the time we reach the site, it is ensured that the backs up batteries are also ready.
- The storage near the rear door have the bullet-proofing done, the same is also for the ROV.
- This whole cabin had a look of a hi-tech area, giving a feeling of a highly equipped lab.
- I felt the sense of strength that maintains calm and cool mind and brain – “ A cold blooded Bomb squad”
- Though the internal door to the crew cabin is less wider, it has good fillets and cushioning which prevents any kind of injuries to my body, even in case of fast movement.

**D. Crew Cabin**

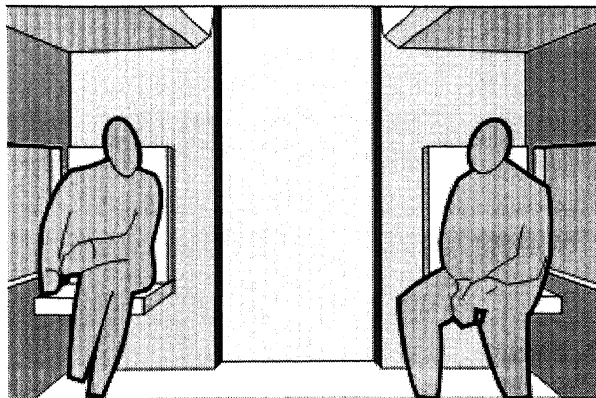
- The crew cabin – sense of homely warmth is what it demands.
- Should calm down my mind and brain and make me ready for the long journey.

**E. On the Run**

We get a call of bomb threat when we were at the station and we started moving to the site with all the equipments and ROV.

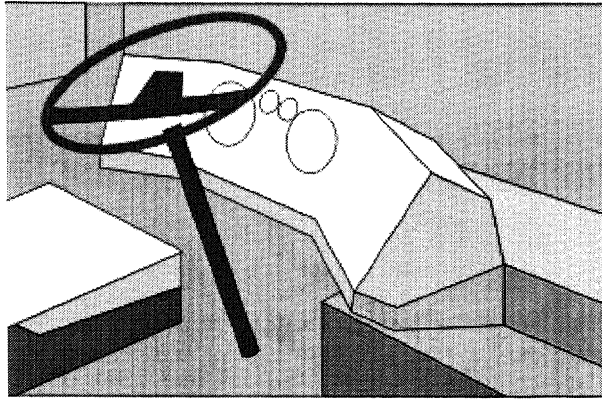
**F. During the journey**

- I read newspaper for some time but after that I need a place where I can keep it properly.
- I talk to my friends regarding what I did in last two days or for the day we were at the docks. I listen to them too. The whole environment is friendly, everybody is sitting and nobody is on the beds.
- All 6 down on the seats, wish these seats were retractable so that guard could also sit and driver also for some time in longer journeys.

**G. During the journey**

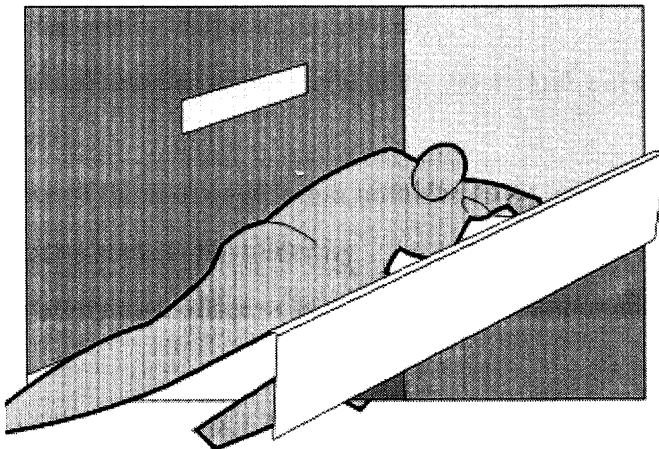
- As were sitting facing each other, we need some cushion at the lower spine level.
- Curtains should not obstruct my seating posture.
- Extra storage for a whisky or beer crate that is for the leisure time the crew enjoys may be during the journey to the site or back from the site. Refrigerator should have also the extra storage for soda, cold water and cold drinks which are required for refreshments.

## H. Driver's Cabin



- Driver puts on a neat and simple music as soon as the vehicle starts moving but squad is insisting on putting some foot tapping music. Ultimately driver changes the music.
- Driver takes out a pan *masala* packet and starts chewing but where will he spit if a.c. is on as windows will have to be jammed.
- Guard is sitting besides the driver; he has his gun fixed on the stand on one of his sides. His helmet is hanging with the back storage which is at the hand level's reach.

## I. During the journey

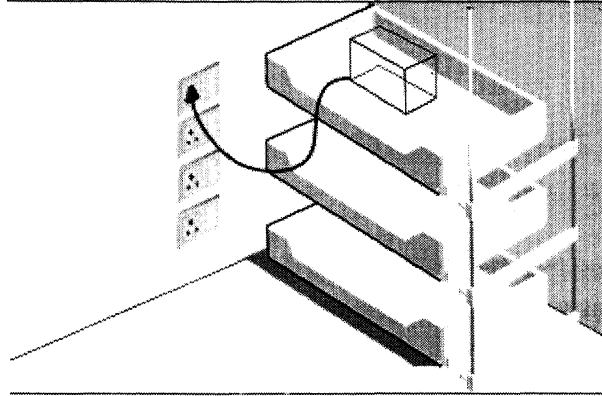


- One goes to sleep
- One goes for maintenance work of the equipments and batteries.
- Two sleep on the seat
- Two try to read something but prefer to look outside.
- There is a hanger for all the magazines on the back side of the internal door for easy and equal access for all. I took a magazine and started reading, felt bored,



pushed it back to the hanger and took out a nice magazine which had topics on hi-tech news.

## J. Details



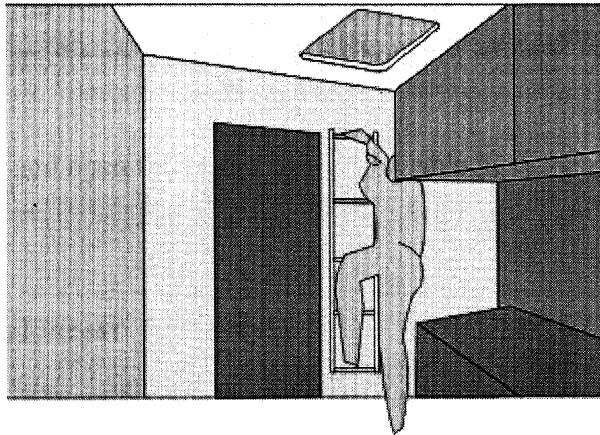
- There are around 3 charging slots on the table top level.
- One of the instruments is giving problems so to mend it, I took out the screw driver and tester from the topmost drawer of the lower cabinet. The first drawer on my right has all the required spanners, wrenches, drivers, etc.
- I have enough lights too to see clearly the circuits or details if any.
- The table top should not allow any screw to be lost but does not allow any dirt accumulation too.
- I can see what is happening in the adjoining cabin.
- I am sitting on a stool snapped temporarily to the floor. And working on the bomb disposal instruments.
- I took the stool out of the storage side and unfolded to sit on it.
- Good that there are extra sockets for soldering.
- I felt like at I am at my own office or lab working on an important electronic gadget.
- Nothing in the storage is making a sound. Everything is tightly snapped.
- The floor holds me when I am standing, i.e. the floor is not at all slippery which helps in my movement during the movement of the vehicle.
- I found a place or shelf for all the ready reference or manuals at my hand's distance.
- Proper arresting mechanism for chargers too and batteries too, a housing mechanism will also do. Good it is inside the shelves on my right hand side

- A niche or a depth in the drawer units can resist the x-y movement and for height a boundary can be provided.

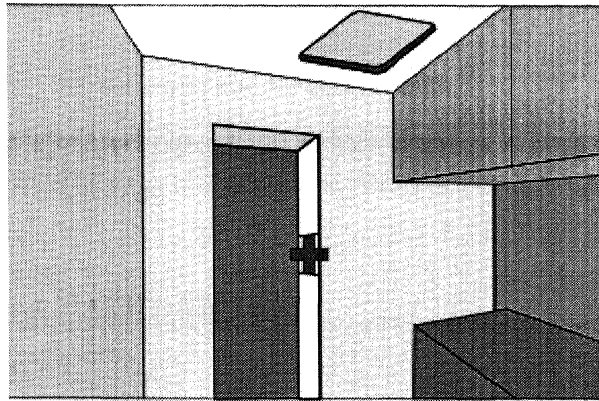
#### K. During break in the journey

- Remote operated vehicle was nicely snapped.
- I came back to my room after putting the controller's battery on charge. The wires length wasn't much but the sockets were nicely provided, nicely thought of locations.
- Almost all were asleep except the guard and the driver.
- I took a peep in driver's cabin, found the music is still on, it was night so we were going to halt on a *dhaba* for our dinner.
- At this *dhaba*, we came out of the back door by opening the half door and so did not show anything suspicious to civilians. The windows are black glass so that nobody can peep in.

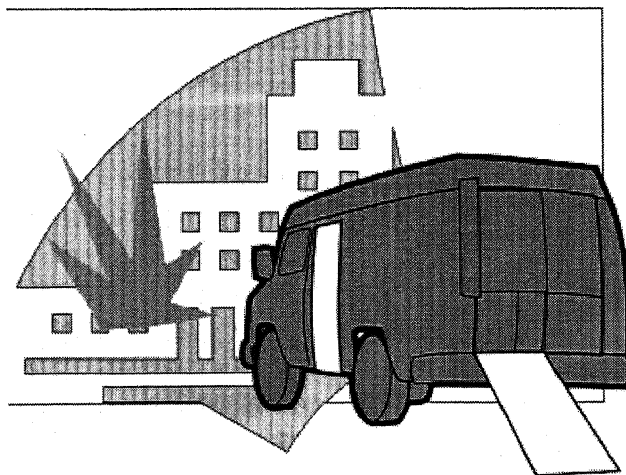
#### L. Defence from attackers



- So we are back on the route.
- We faced terrorists group. Guard was already shot; driver was somehow carrying us to a safer place.
- We took our guns from the cabinet at the rear cabin, near the door, kept on firing from the gun openings in the crew cabin.
- One of the crew members was besides the driver. One was at the rear, opened the half door, top half, and started firing.
- I was mounting on the light machine gun on a stand with a ladder which usually remains folded and hidden in the partition.

**M. Storages**

- I got hit but to my luck the first aid box was placed in the left hand side of the door of the storage.
- I was on the bed for a while to regaining my strength.
- Terrorists were dead but we were panting hard and ready to reach the site of bomb threat.
- A bed sheet was taken out from the two feet wised storage space between two compartments.
- My colleague got a glass of water from the other side of the storage.
- Some resorted to smoke and some took out a bottle of whisky. The storage had it all.
- Roll out the seats and open the centre table. The table has niches for three glasses to be fixed.

**N. Site of Bomb disposal threat**

- It was not an unplanned event or task or activity. Everybody knew what to do, as if some invisible commander is giving them orders one by one.

- Open both the rear doors and two soldiers dropped down to pull out the ramp and dropped it.
- Other started taking out suitcases and its equipments.
- The ramp was made of steel pipes fixed to ball bearings at both ends thus pushing down cases wasn't a big task.

## 4.2 STUDY OF SWARAJ MAZDA CHASSIS

After understanding the various possibilities regarding the donor chassis for the vehicle, the 14' chassis of Swaraj Mazda was chosen. This chassis is a popular chassis for the school buses and ambulances in India. The chassis builders have their own bus in the same model and it proves to be a low maintenance bus in the market thus preferred. The other factor is its load bearing capacity which is according to the Indian rugged conditions. This chassis is one of the toughest in the light commercial vehicle class. The chassis was suggested by the primary client, Research and Development Establishment (Engineers), Pune. The details of the chassis are as listed in the table no.---. The chassis comes with the factory built cowl (driver's cabin) which can be removed as per the requirements.



**Plate 4.1 Swaraj Mazda Chassis**

<b>RANGE</b>	T3500 (DIESEL) 4 WD - BT
Payload/Kgs	2500
Seating Capacity	2+1 (in the driver's cabin)
<b>WEIGHTS</b>	
Curb Weight(Kg)	3750
GVW(Kg)	6250
<b>DIMENSIONS</b> (in mm)	
Wheelbase	3365
Rear Overhang	1570
Overall Length	5979
Cargo Deck Length	3630

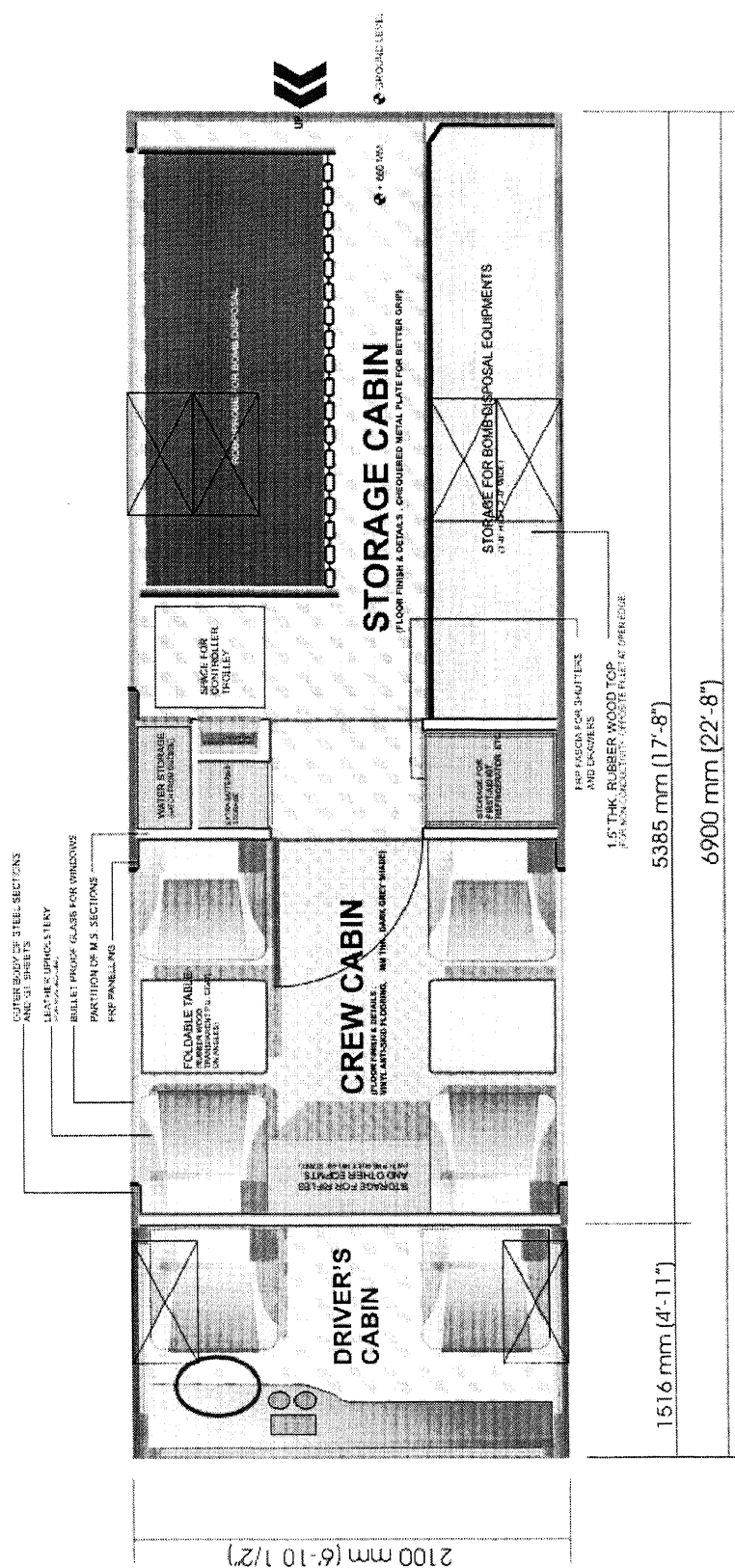
**Table 4.1 Specifications of Swaraj Mazda chassis**

### **4.3 DESIGN DIRECTION 1 - EXTENDED CHASSIS & SINGLE DOOR, FACTORY BUILT COWL**

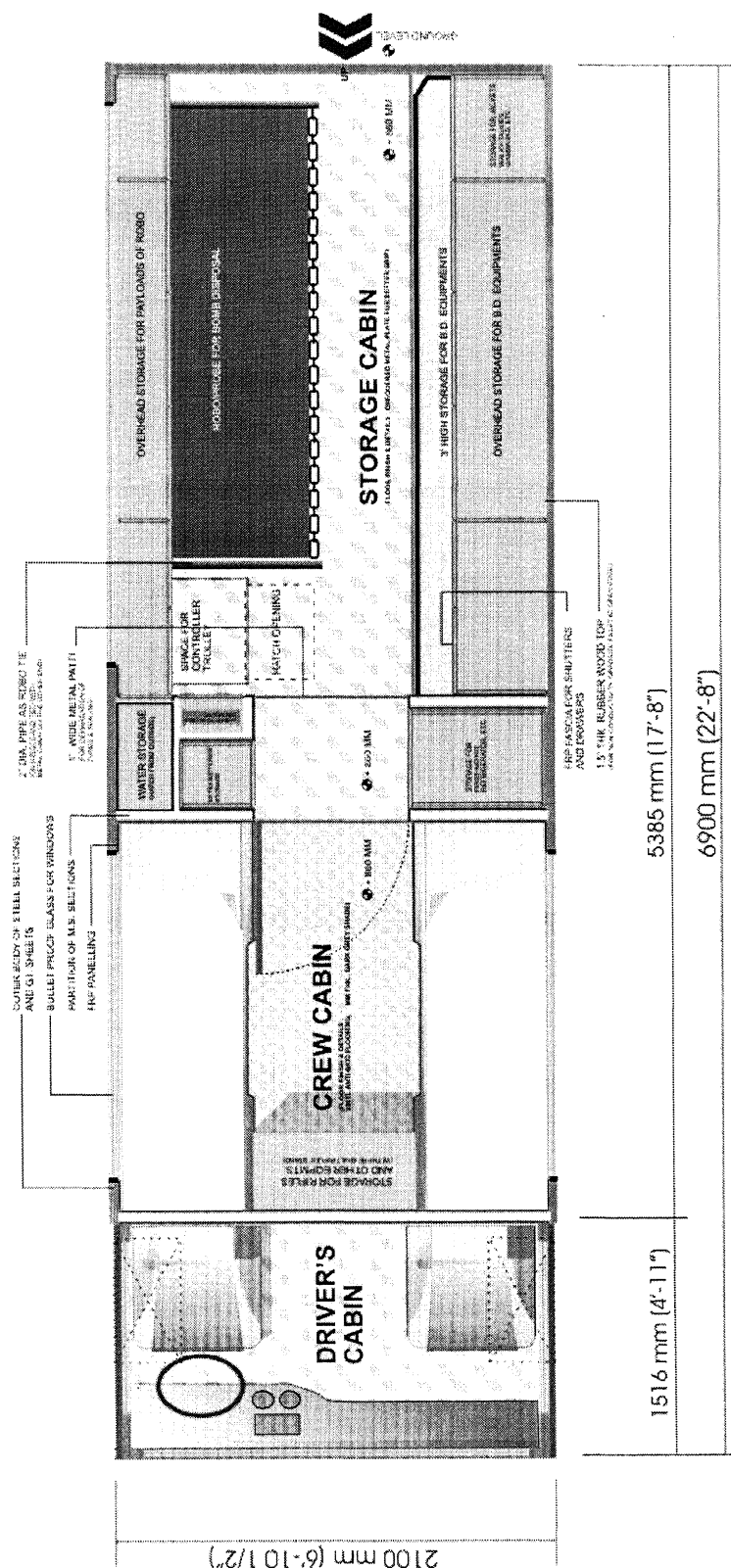
As mentioned in the study of T3500 chassis, the factory built length is 14 feet but this length can be extended up to an extent of 60% of distance between the rear and front wheels. In the first design approach, the chassis is extended 6900 mm. This was done for more space and ultimately reaching an ideal design.

#### **4.3.1 Features of Interior Planning**

1. The chassis is divided into 3 major areas – Driver's cabin, Crew cabin and Storage cabin
2. Rear door serves the storage and crew cabin. A straight passage of 2' width is the link from crew cabin to storage cabin.
3. Tasking:
  - During journey to the bomb threat site, crew cabin is used the maximum plus the areas nearby the crew cabin.
  - During bomb disposal task, areas used are storage cabin without disturbing the crew cabin.
  - There is a common zone in between the two cabins which is of common storage. This shaft actually helps in storing the basis and long term items like first aid box, water, refrigerator, beddings, etc.
4. Seating arrangement in the crew cabin is planned same as Indian sleeper coach with sleeping berth on top.
5. The crew cabin also has the storage for rifles and ammunition which is utmost important and easily accessible in case of an attack.



**Fig. 4.2 Interior layout at Chassis level**



**Fig. 4.3 Interior layout at upper level**



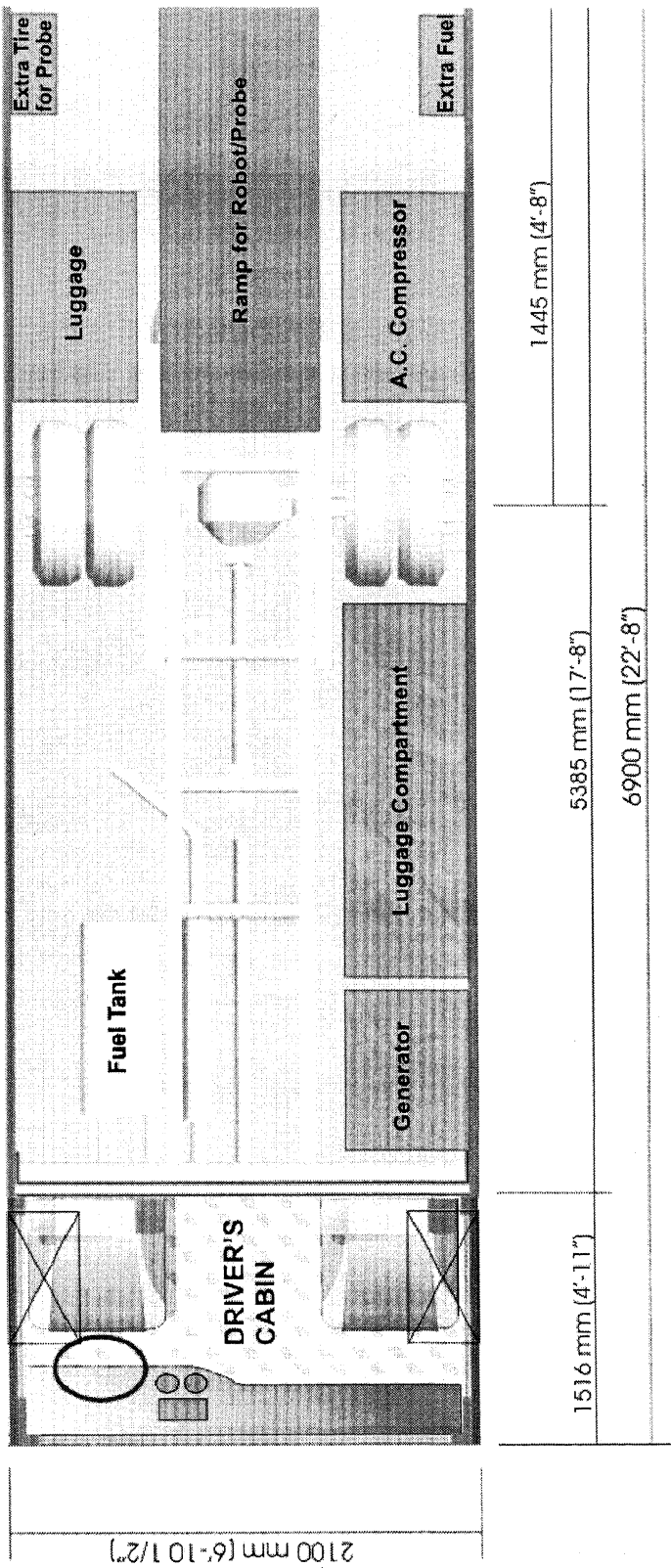


Fig. 4.4 Layout below chassis level

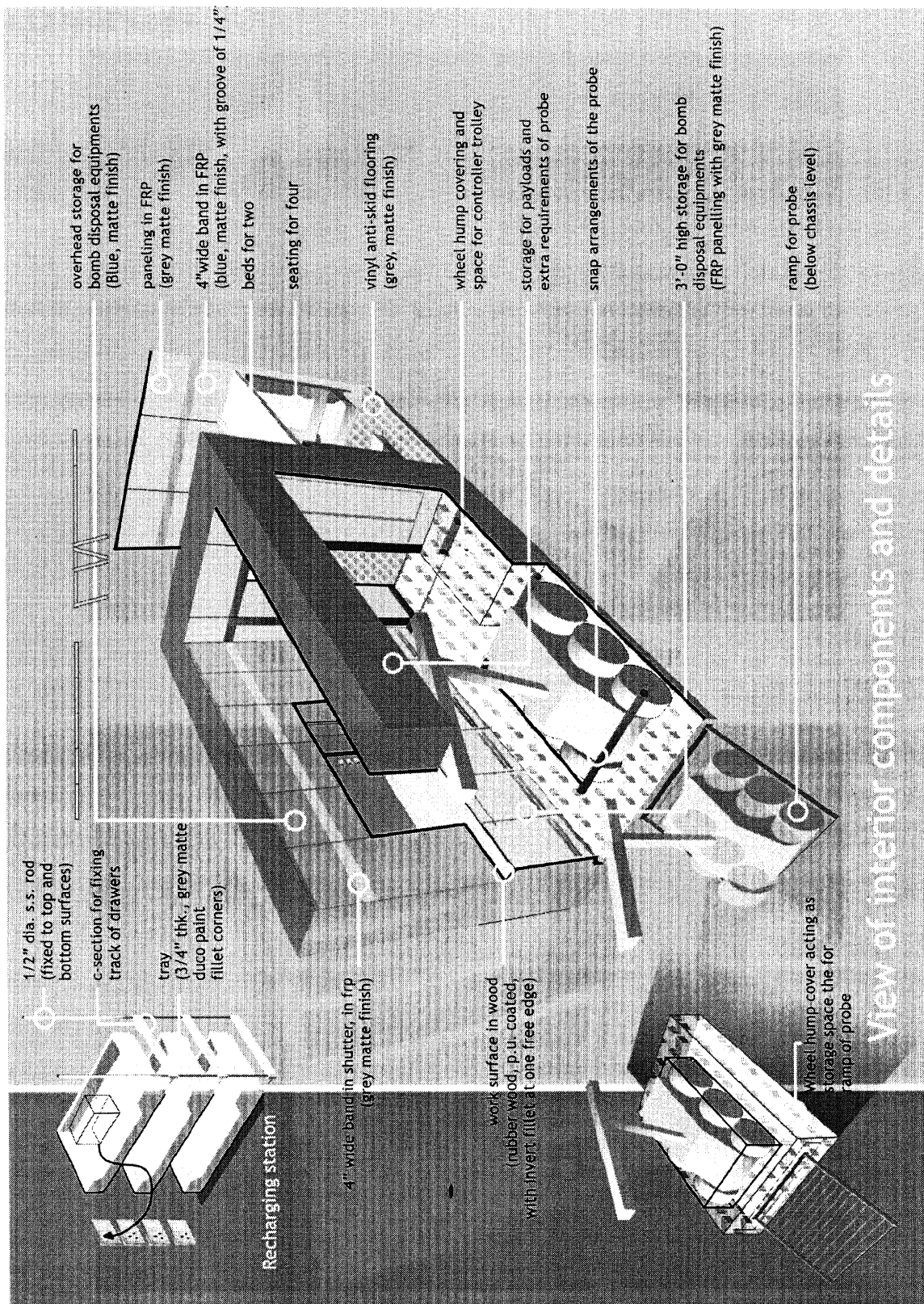
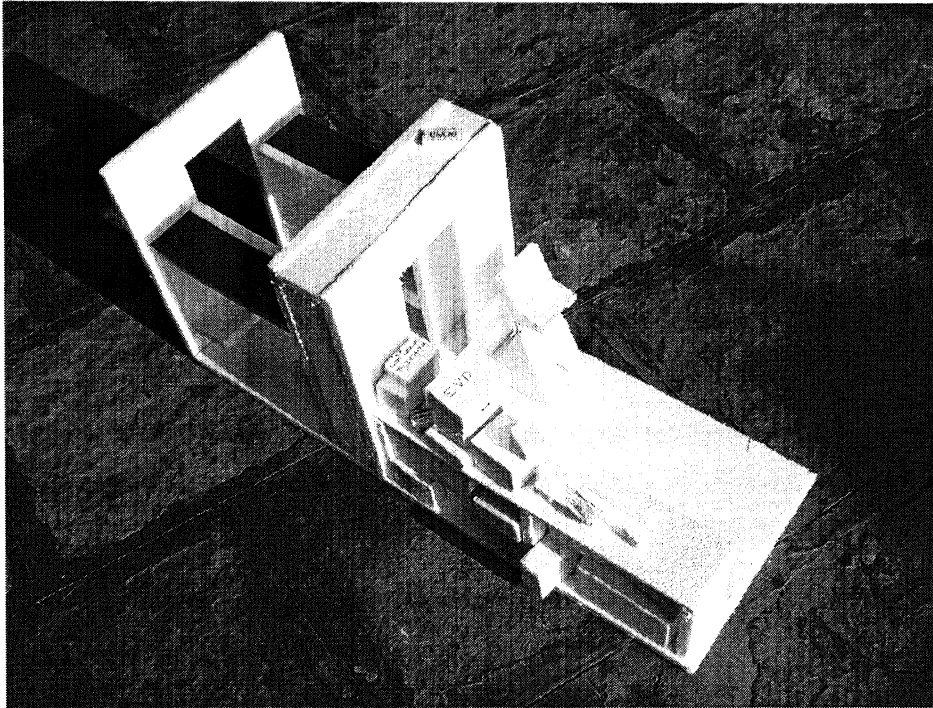
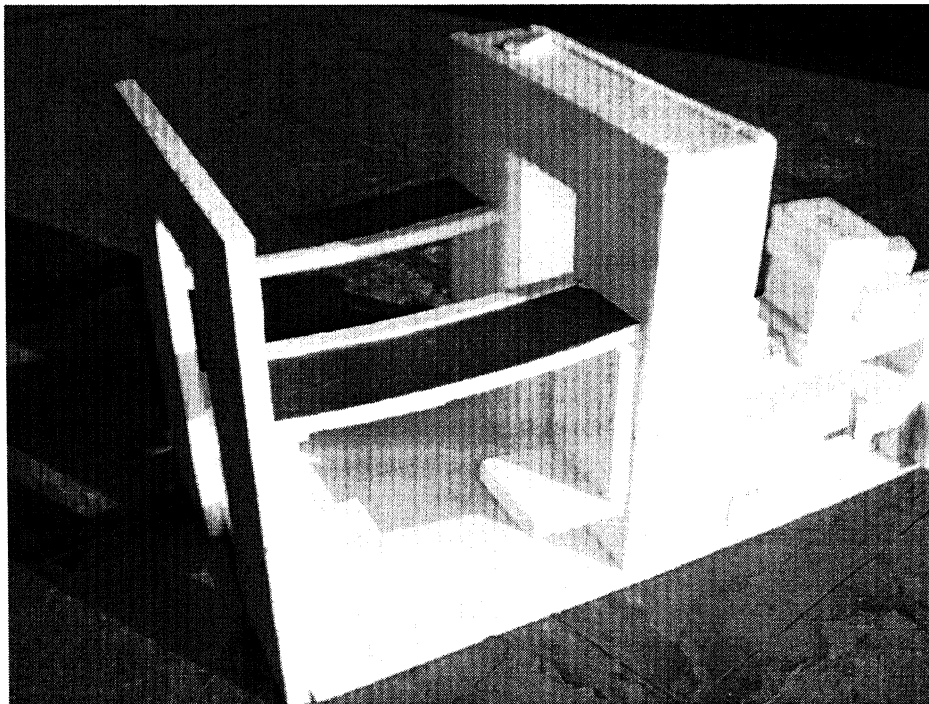


Fig. 4.5 View of interior components and details

### 4.3.2 MOCKUPS

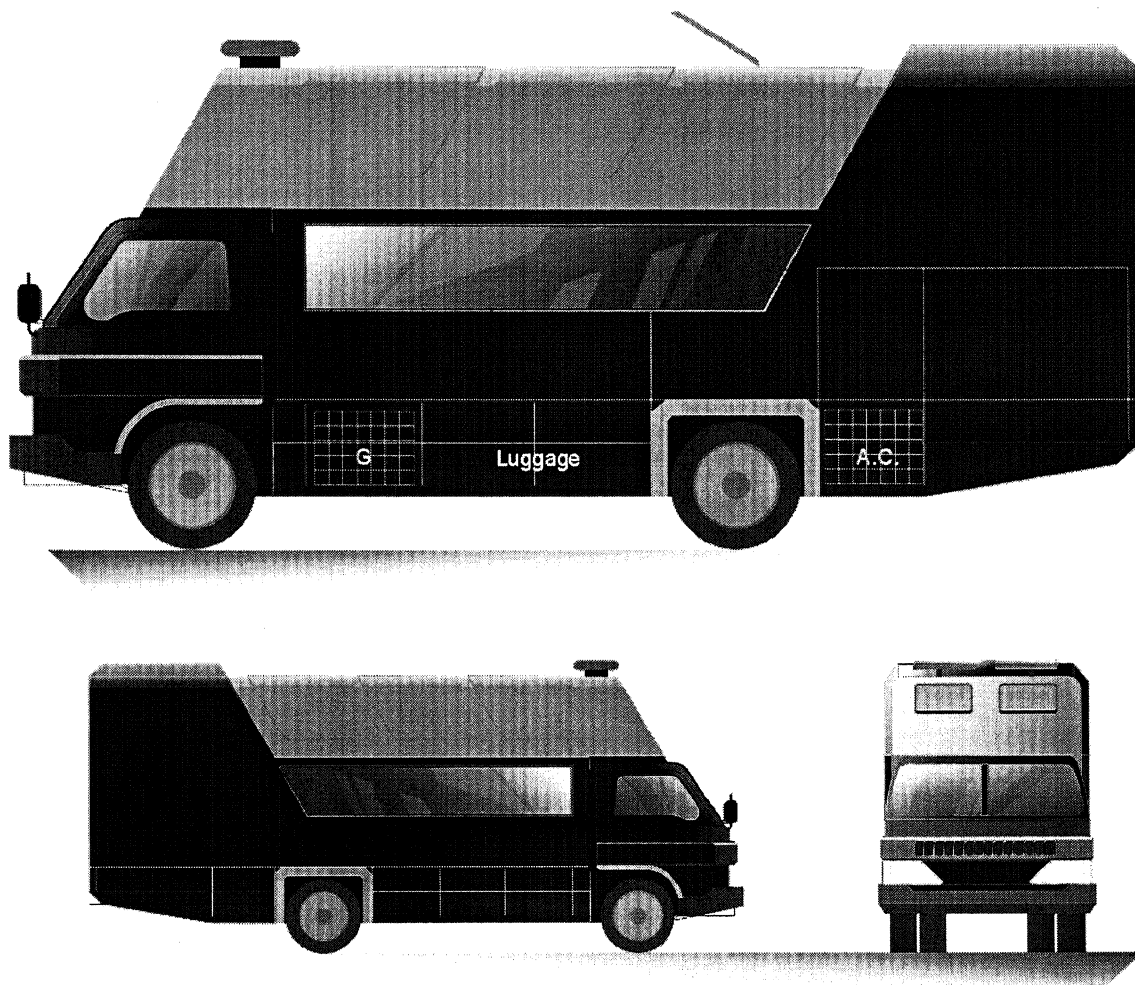


**Plate 4.2 Bird's eye view of the mockup**



**Plate 4.3 View of Crew cabin in the mockup**

### 4.3.3 Exterior Styling

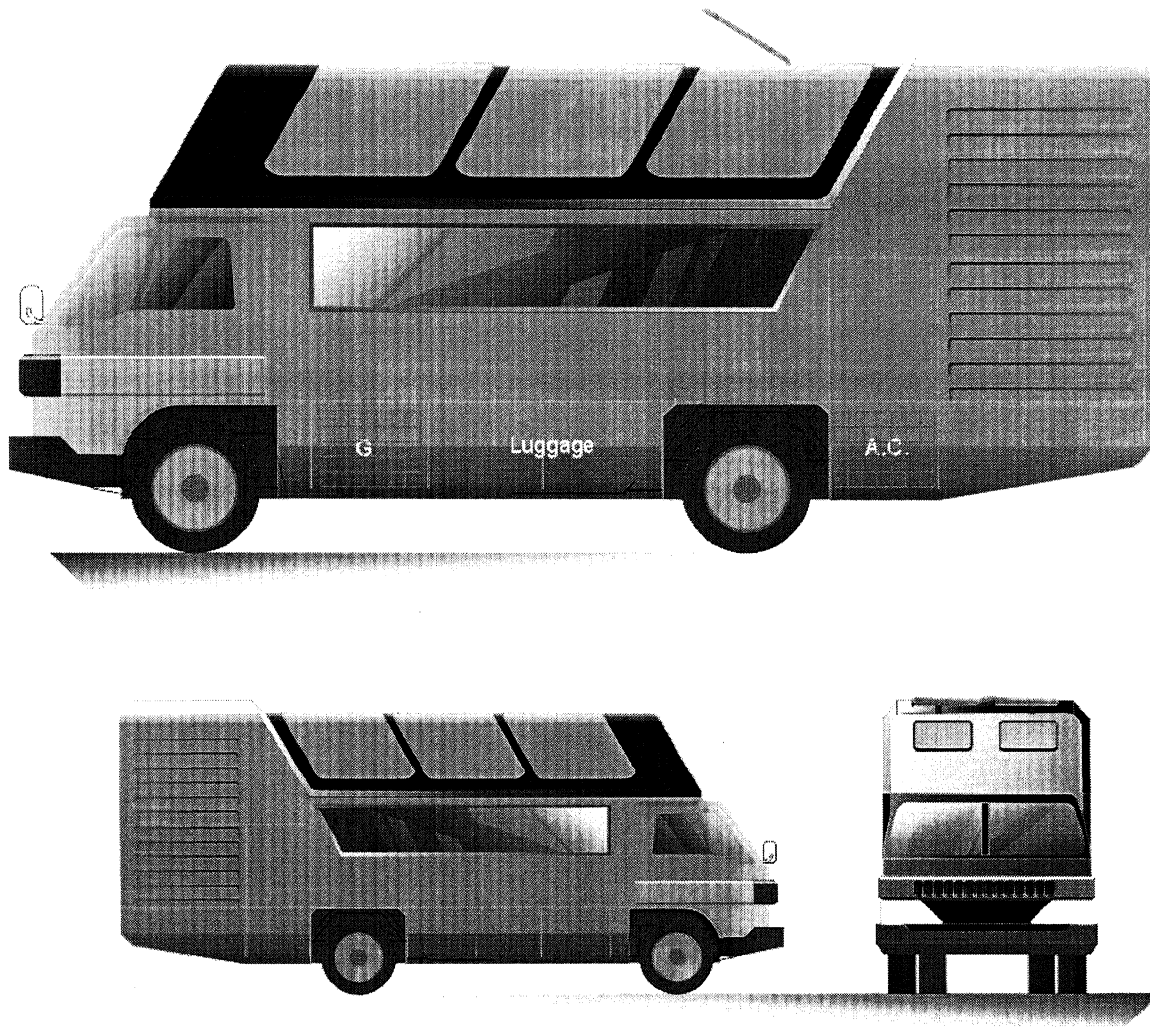


**Fig.4.6 Elevations of the concept**

**Features:**

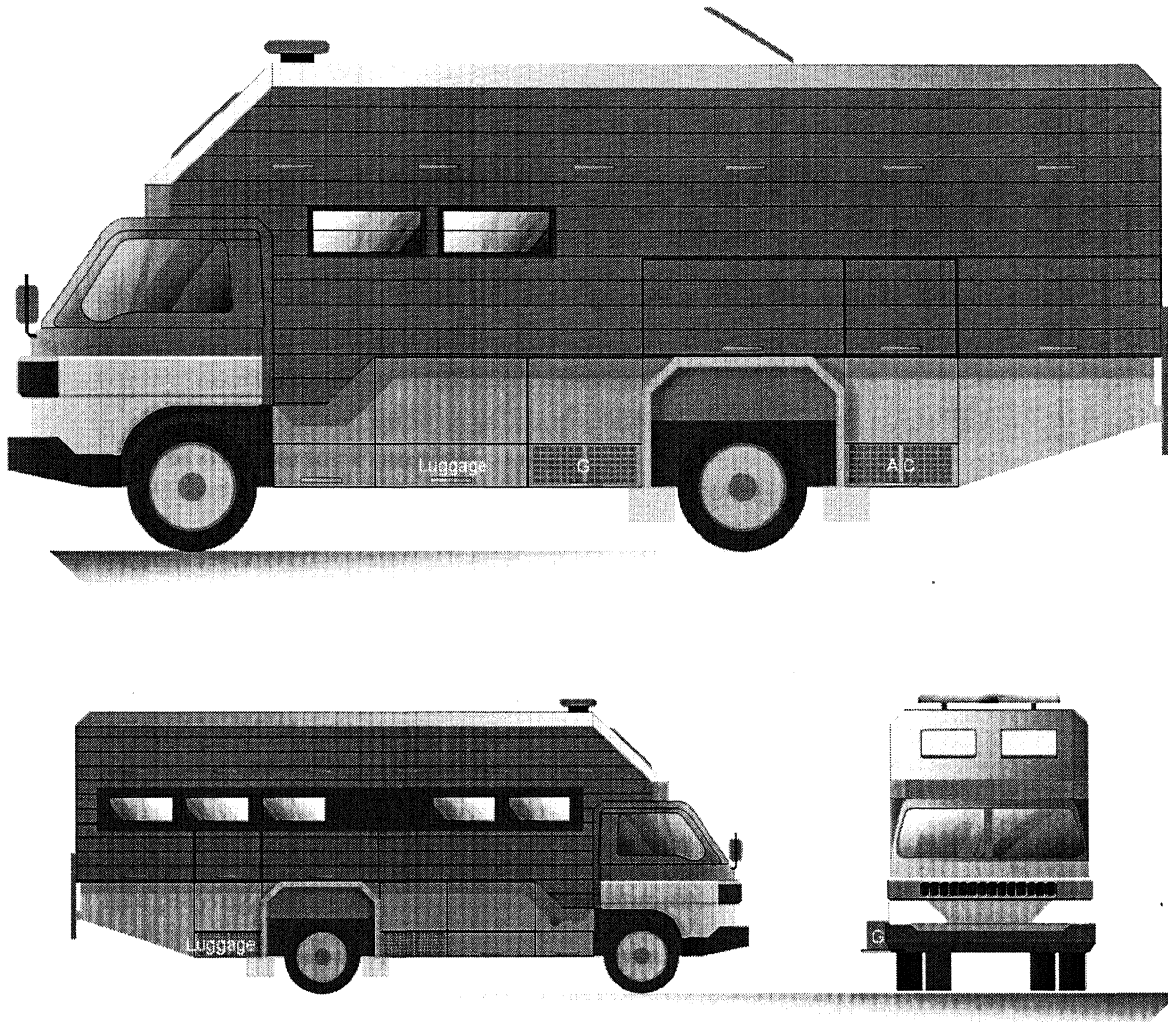
- The cowl of the chassis is maintained as it is and the rest of the body is integrated with it.
- As the chassis is extended, the division of masses is done to make it look much lighter than it would look otherwise.
- Embossing in sheet metal is used to give it a look of forging.
- Though, the color and the mass of the vehicle give a feeling of heaviness, long faking glass window is used to make it look more luxurious. So, a mixture of both, luxury and ruggedness is displayed.
- Some of the functional features like the slope under the back portion of the vehicle were incorporated to ensure its safety on all kinds of speed breakers in city roads.





**Fig. 4.7 Elevations of the alternate concept**

- The concept gives the freedom of using the colors in combination, especially the military certified colors like the khaki, black, green, etc. A lighter color will make the vehicle look lighter and maneuverable.
- The front face of the vehicle is modified by changing the radiator grill and lights. These lights are readily available in the market.



**Fig. 4.8 Elevations of the alternate concept**

- This is the concept 3 for exterior styling in the same range. The basis of this concept is to use boxy effects and give the vehicle an effect of much more rugged looks.
- The whole mass is divided into two different parts, upper heavy parts and lower lighter part. This division is taken from the military trucks as they prove to be a vehicle which is out of normal public, a position of the king, commanding attire.
- The flutings on the upper green surface are used to divide the surface which would have remained flat otherwise and might give problems in longer run.
- Heavier handles and fittings are used on the exteriors to make it more rugged in use.

#### **4.4 DESIGN DIRECTION 2 - SMALLER CHASSIS & DOUBLE DOOR, FACTORY BUILT COWL**

After discussion with the client on the first concept, it was understood that maneuvering a longer chassis on city roads is a big problem. On the other hand, shorter chassis is the best for city roads. So this concept deals with the normal chassis size and factory built cowl.

##### **4.4.1 Features of Interior Planning**

- The interior planning is based on the division of tasking. It is divided into 3 major areas: Driver's cabin, Crew Cabin and Storage Cabin. Each area is accessible through its own doors thus not interfering with each other's zones.
- A passage of 2' wide is the link from crew cabin to storage cabin.
- The seats in crew cabin are arranged together so that the interaction between the members of the team is increased and also that they can indulge in some activities like playing cards, drinking together, eating, etc.
- The storage cabin is designed to take the maximum loading and also to house in ramp in its floor, just above the chassis.

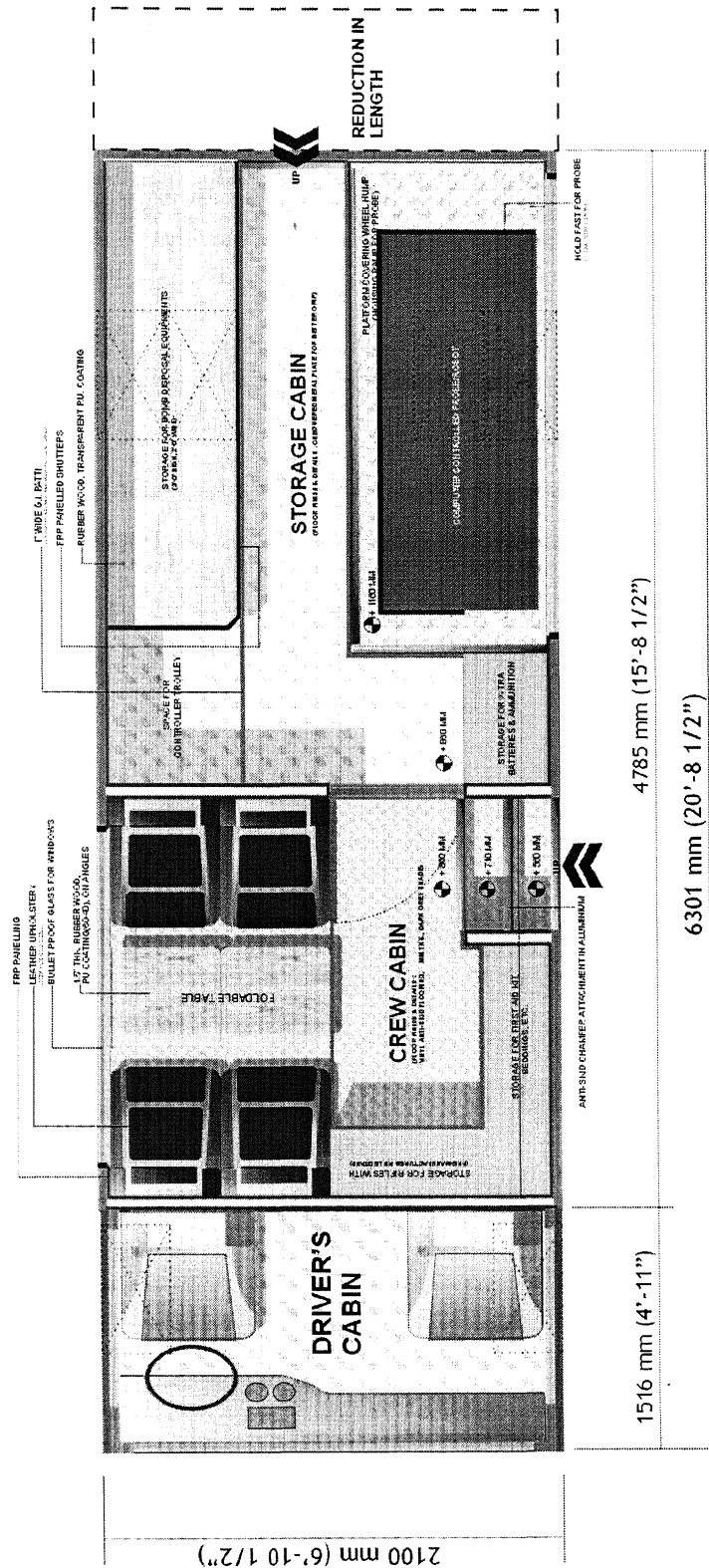


Fig. 4.9 Interior layout at Chassis level



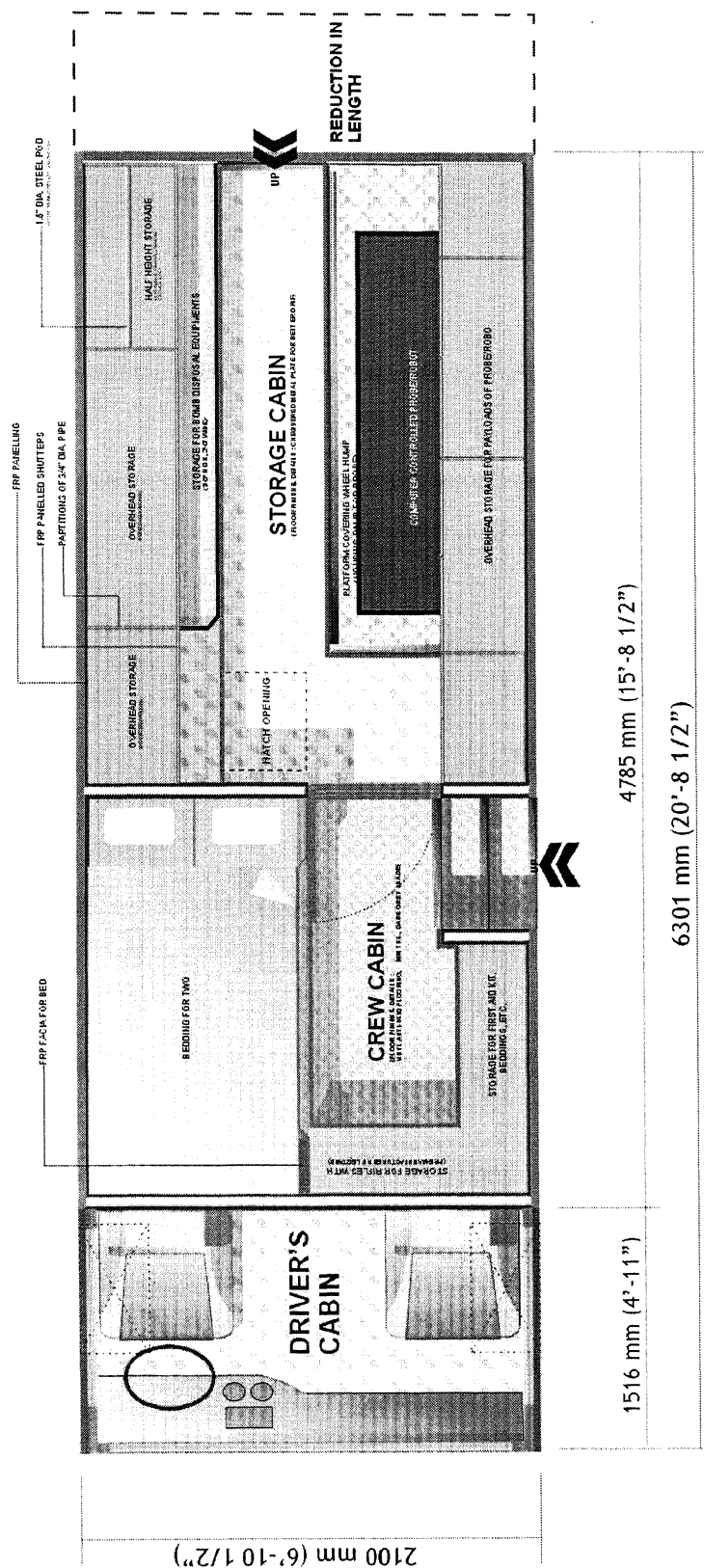


Fig. 4.10 Interior layout at upper level

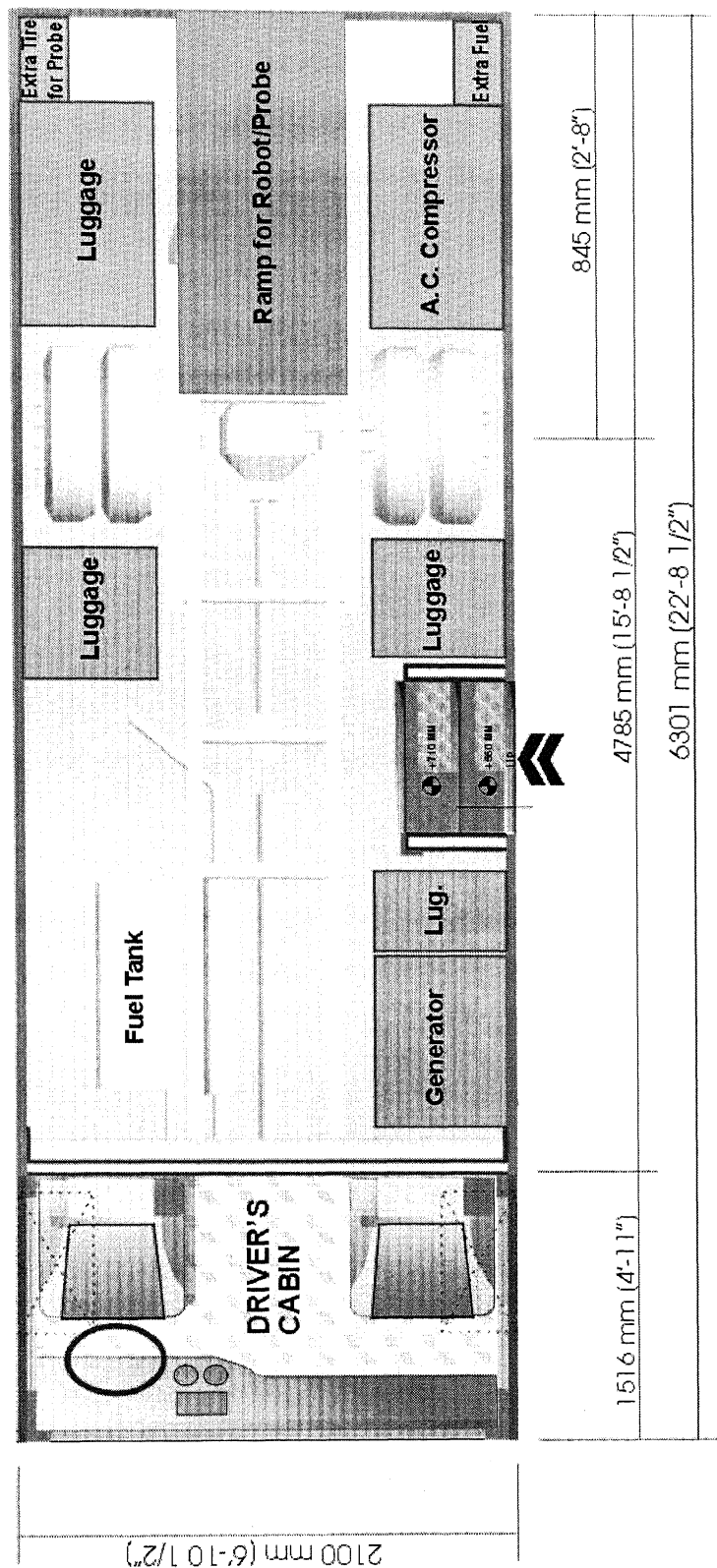
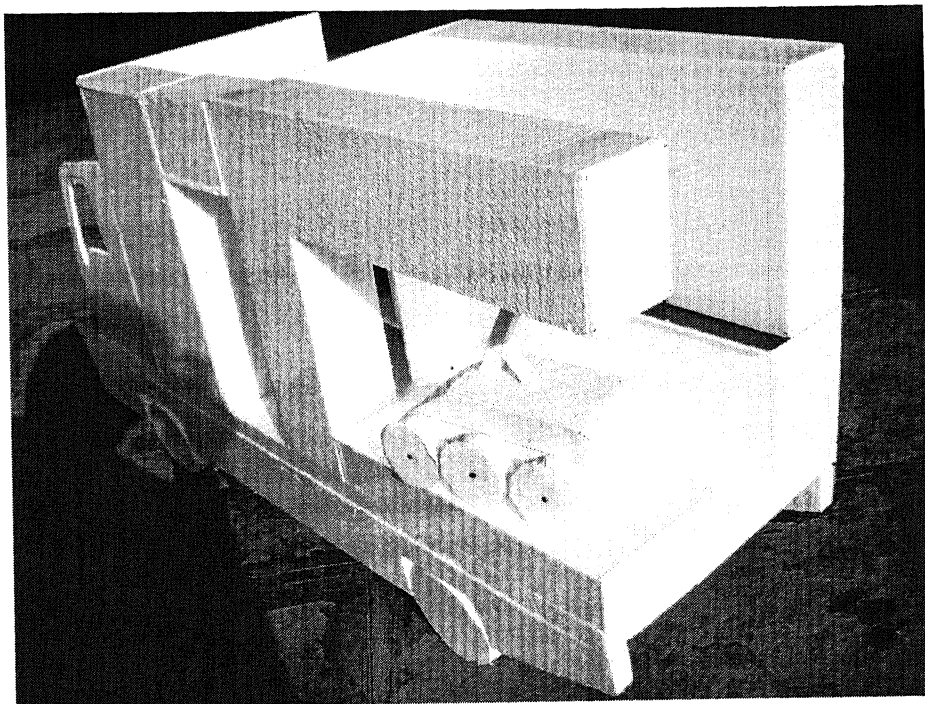
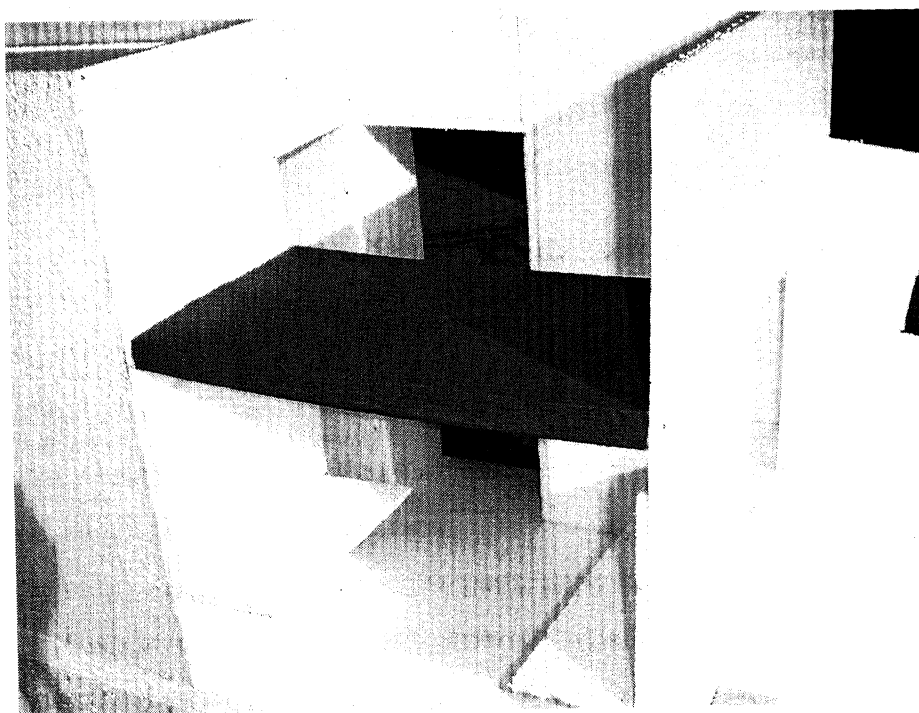


Fig. 4.11 Layout below Chassis level

#### 4.4.2 Mock Up



**Plate 4.4 Overall view of the mockup**



**Plate 4.5 View of Crew cabin in mockup**

#### 4.4.3 Exterior Styling



Fig. 4.12 Elevations of the concept 1

#### Concept 1

- As far as possible, the curves are avoided and straight lines are used. Curves make a surface look more fragile and straight lines and sharp curves make the vehicle look more rugged and mean.
- The whole surface is divided in two parts, upper heavy part and lower lighter part. There is a level different of 50mm between these two surfaces to maintain the background and foreground basis.
- Elements like flutings on the upper surface are used to break the monotony of the flat surface and also perform the function of strengthening the sheet metal.

- Side door for the crew cabin divides the whole surface very efficiently and acts a heavy element giving the vehicle a meaner look.



Fig. 4.13 Elevations of concept 2

### Concept 2

- This concept also uses the same concept of using straight line and sharp curves rather than using the highly filleted curves.
- The heavy riveting done on the borders of the upper surface is inspired from the riveting of the goods trains in Indian railways. That gives the vehicle a much more forged and stronger look.
- The border for windows and door is intentionally done to give it a look of a vehicle which is related to law and stronger.

## **4.5 DESIGN DIRECTION 3 - SMALLER CHASSIS & DOUBLE DOOR, MODIFIED COWL**

### **4.5.1 Features of Interior Planning**

The interior planning is same as the design direction 2.

### **4.5.2 Exterior Styling**

- Some of the features like lower guards for the main body and borders for the windows and doors are incorporated in this concept direction.
- Contradictory to earlier concepts, this concept involves use of curves but controlled ones so that the mean features of the vehicle are still maintained. These curves add on the aerodynamic behavior of the vehicle and also luxury factor.
- The windows and door with a continuing border divide the surface in vertical way. On the other hand, the side door divides the surface in horizontal manner. The other feature is the GI flat section which runs like grid on the surface and divides the surface in small chunks. The flat section is actually a functional feature which is used to hide the pop-rivets which are used to join the GI sheets to the box section of the vehicle structure.
- The front portion of vehicle has a new grill which shows ruggedness and hugeness.
- The lights are also used to make the vehicle look taller and used in combination of 3 lights.
- Handles on the sides of the vehicle are used for the functional purpose to reach the top of the vehicle and awning arrangements. These handles are inspired from the various military vehicles which are usually for the off-road tasks.
- The lower guard of the vehicle has a slope to give it an effect of mine-protected vehicle even though it is not. The feature is used in mine protected vehicle so that the surface area facing the mine blast is reduced and thus the bullet-proofing required also reduces.
- Chamfers at proper places helps in movement of the eye on the surface.



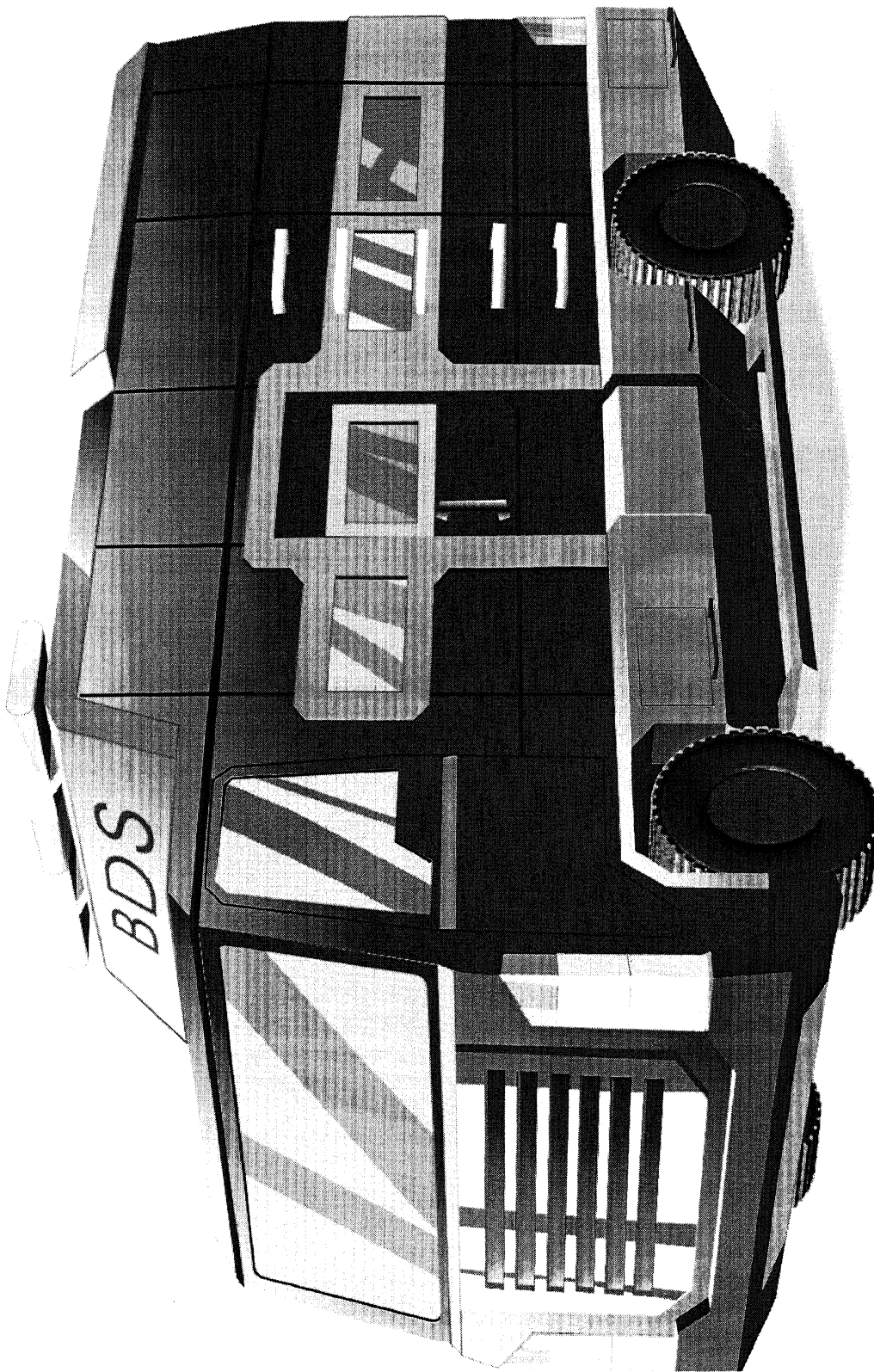
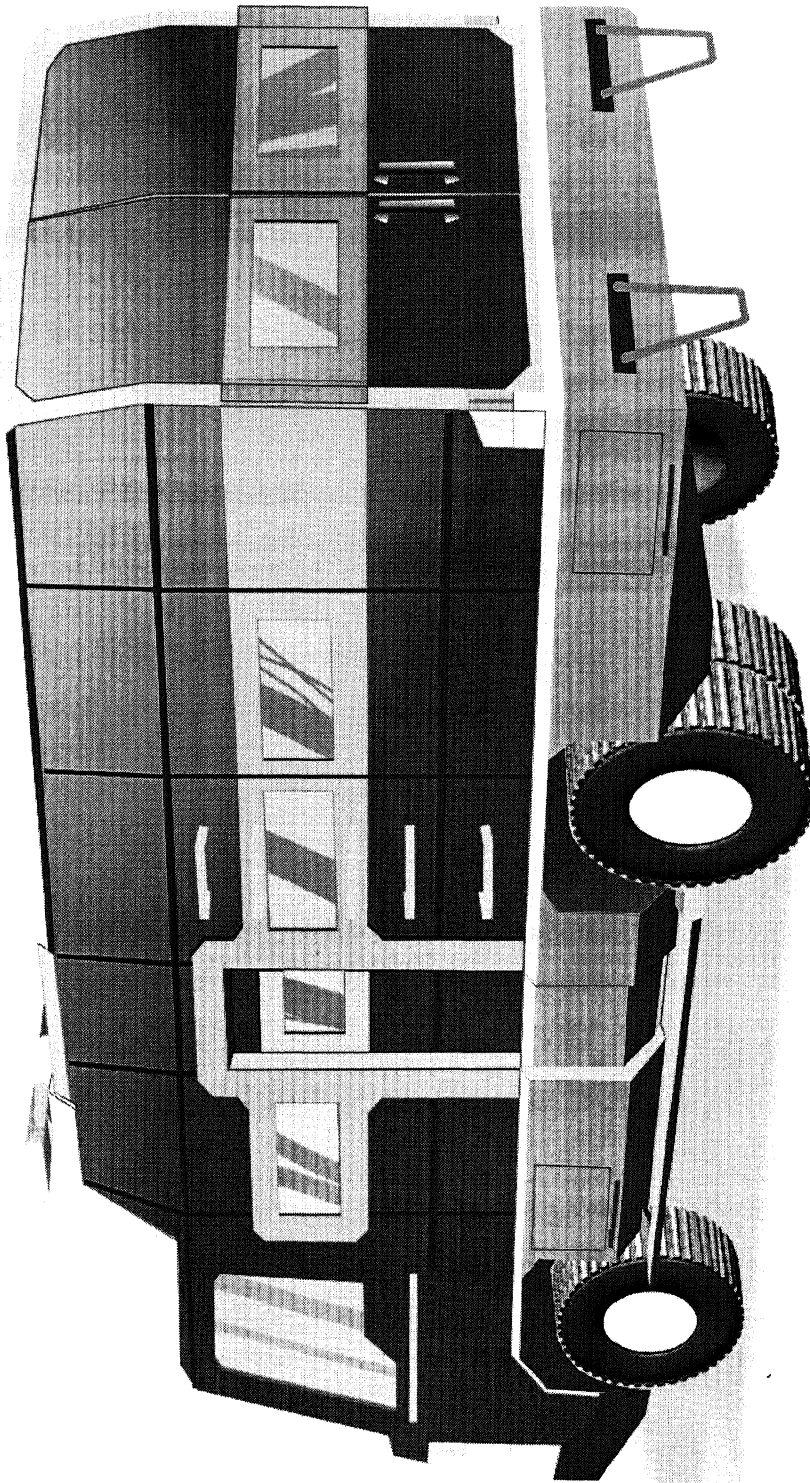


Fig. 4.14 Front view of the Design direction 3



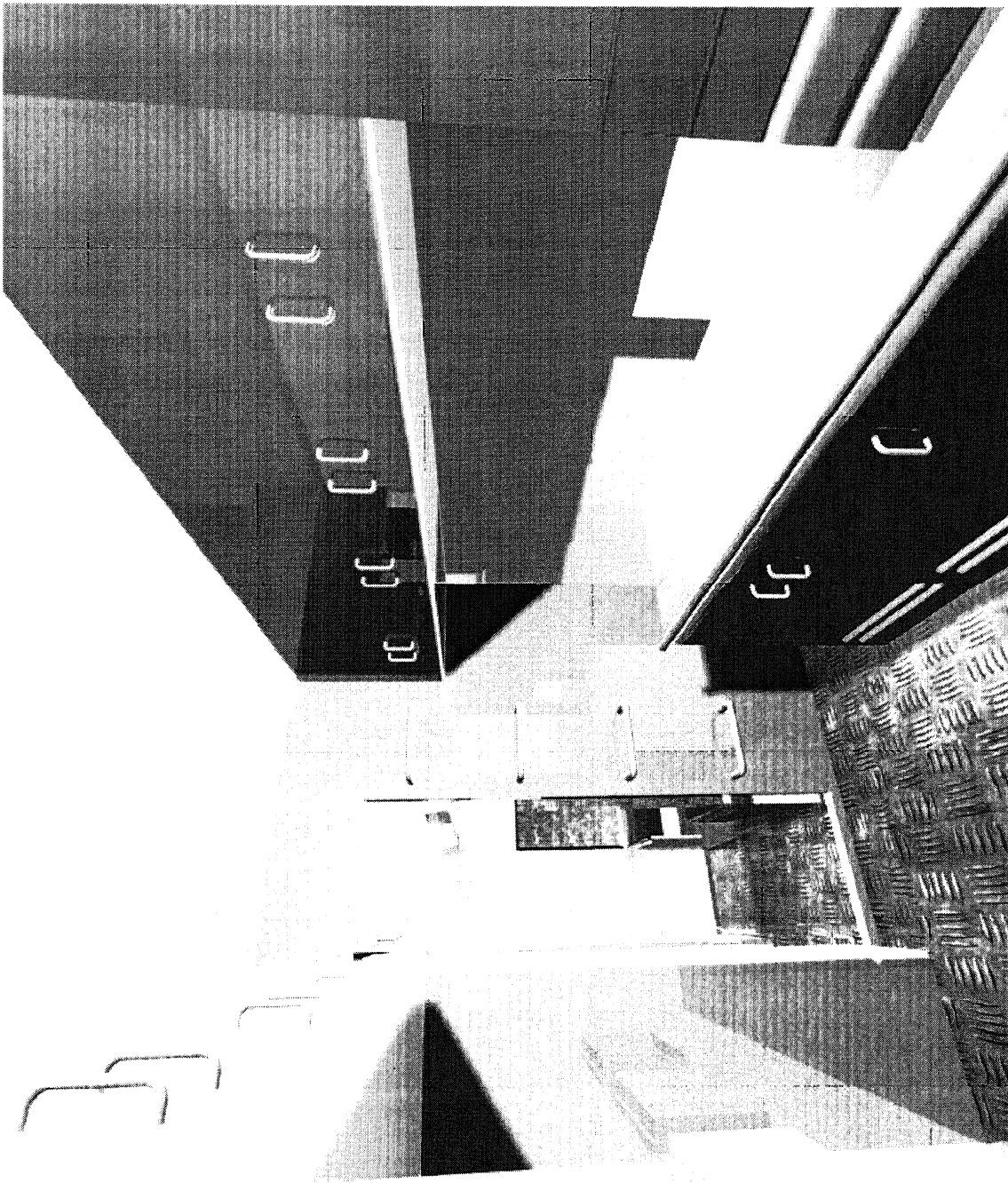
**Fig. 4.15** Rear view of the Design direction 3



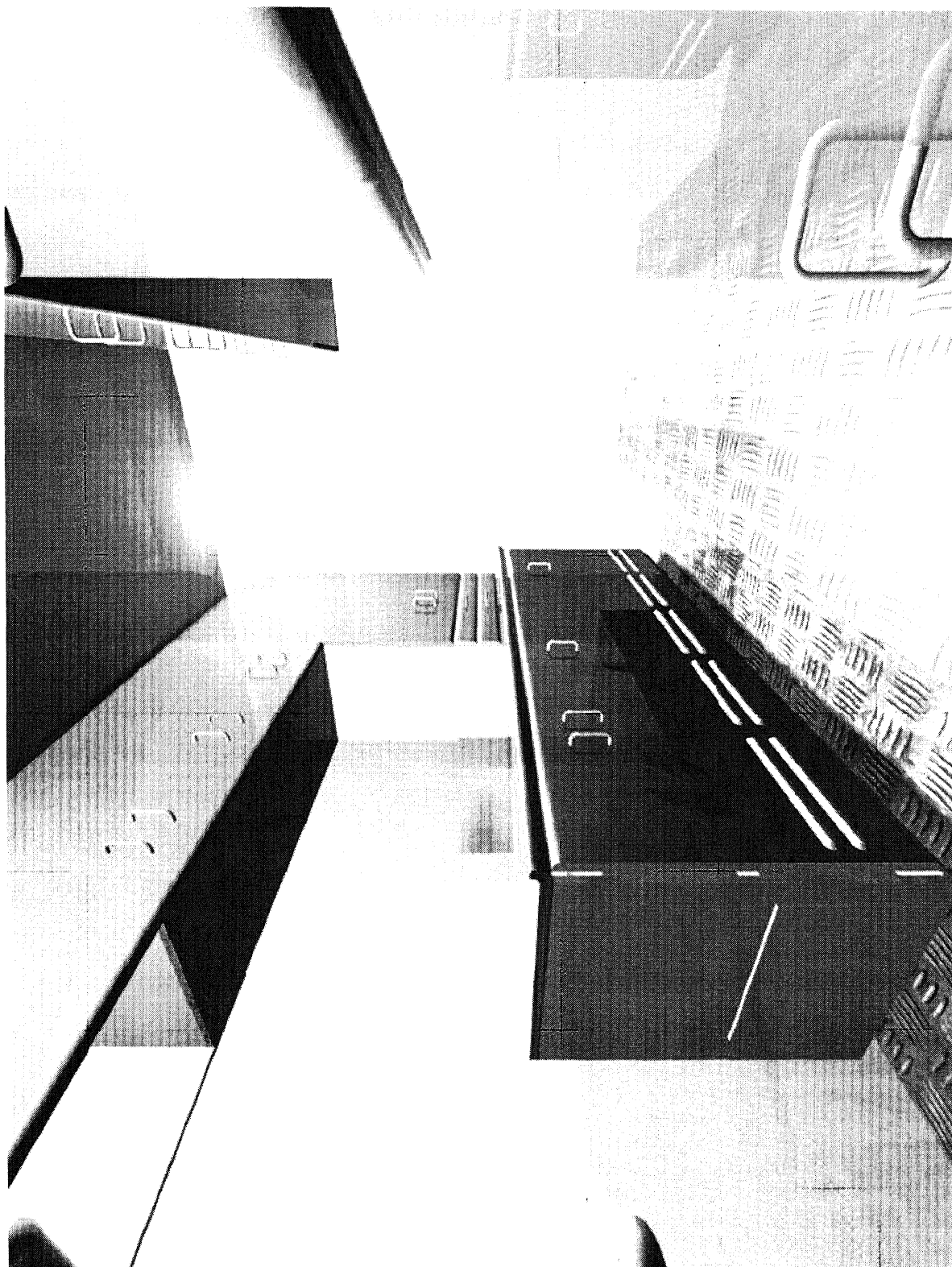
#### 4.6 CONCEPT VALIDATION

FACTOR	CONCEPT 1	CONCEPT 2	CONCEPT 3
Scenario 1 – On the Docks			
Scenario 2 – On the run			
Scenario 3 – On site			
Scenario 4 – Back Home Journey			
Aesthetics			
Ambience (Inside)			
ROV Movement			
Fabrication Timeline required	2 months	2 months	2 months

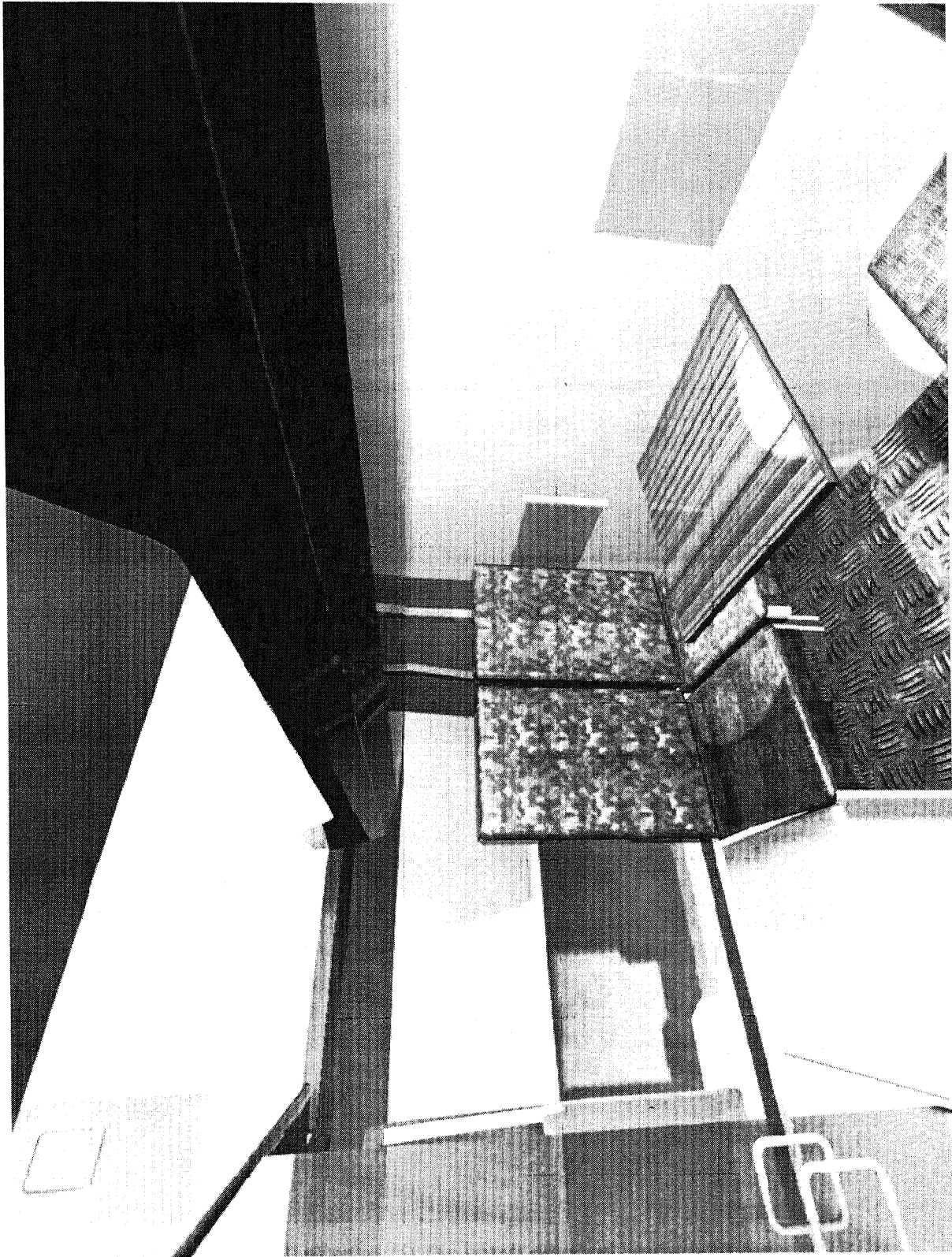
#### 4.7 DETAILS FOR CONCEPT 3(CHOSEN CONCEPT)



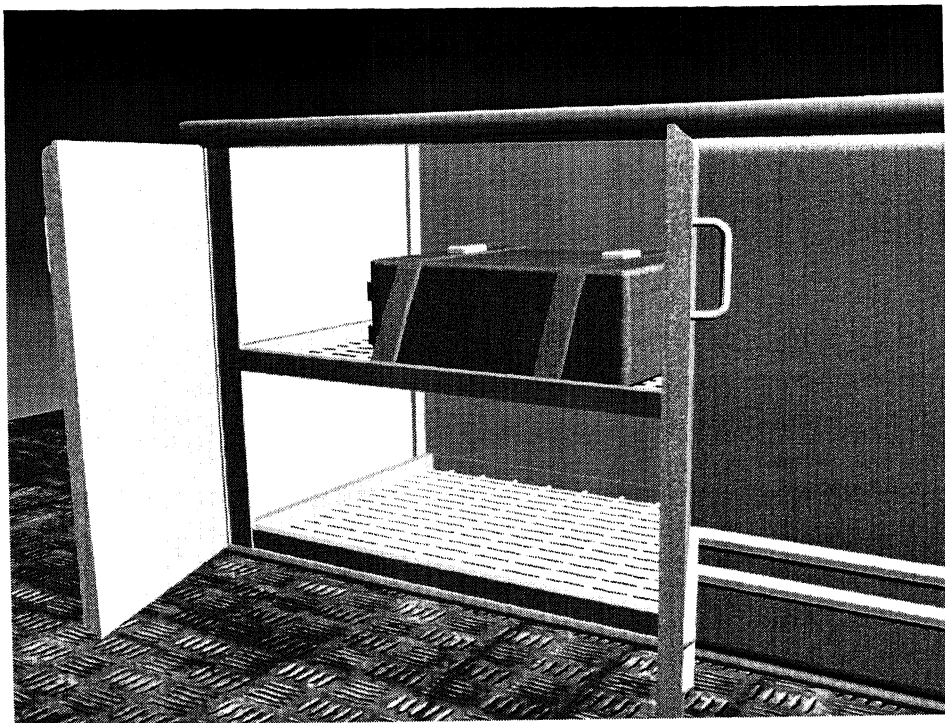
**Plate 4.6 View of Storage cabin from rear door's side**



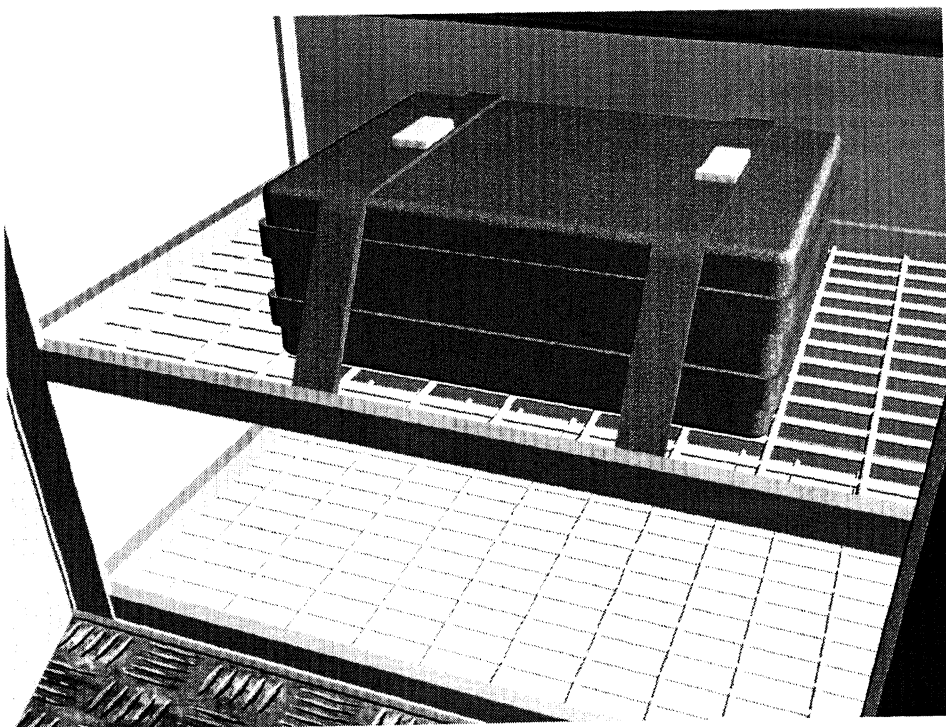
**Plate 4.7 View of Storage cabin from Crew cabin's side**



**Plate 4.8 Crew cabin**



**Plate 4.9 Storage cabinet**



**Plate 4.10 Detail of snap for the bomb disposal equipment cases**

DRAWINGS

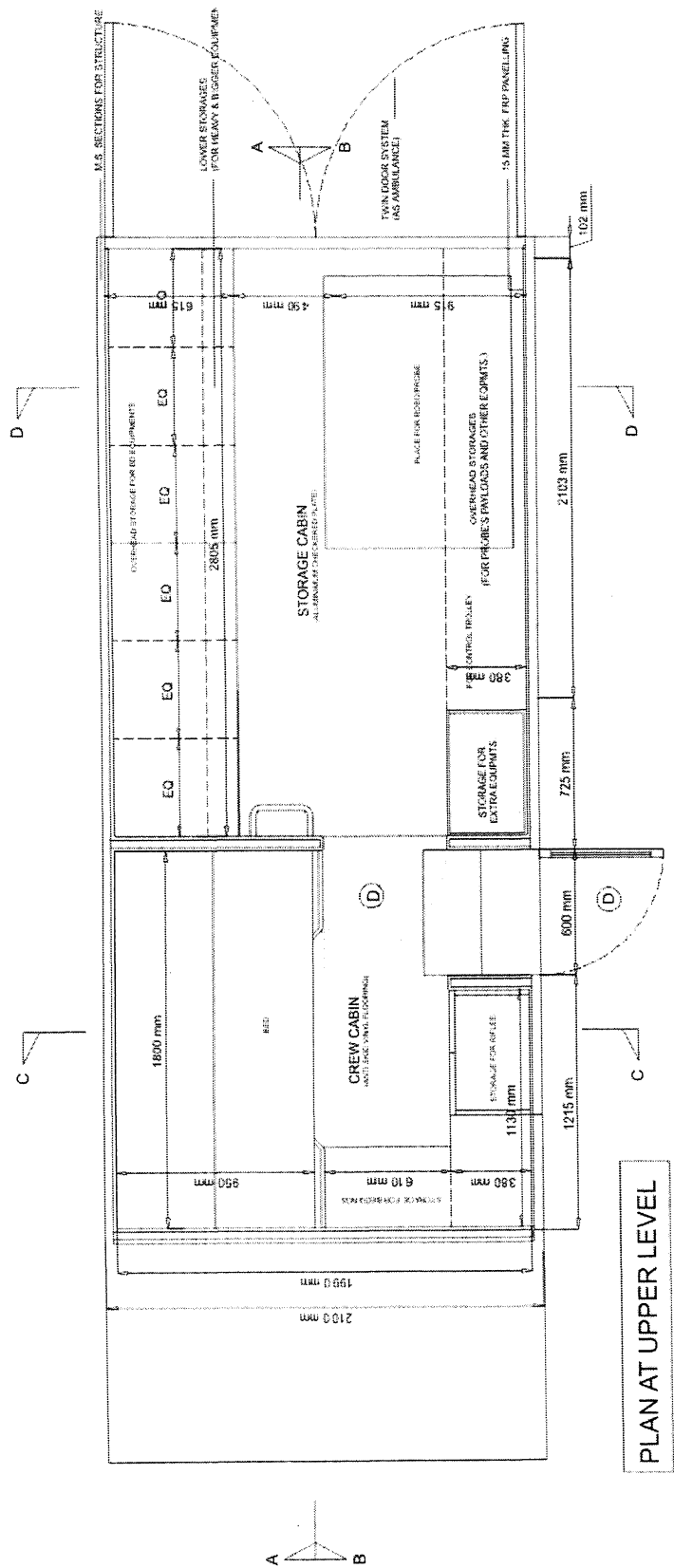


Fig. 4.16 Plan at Upper level



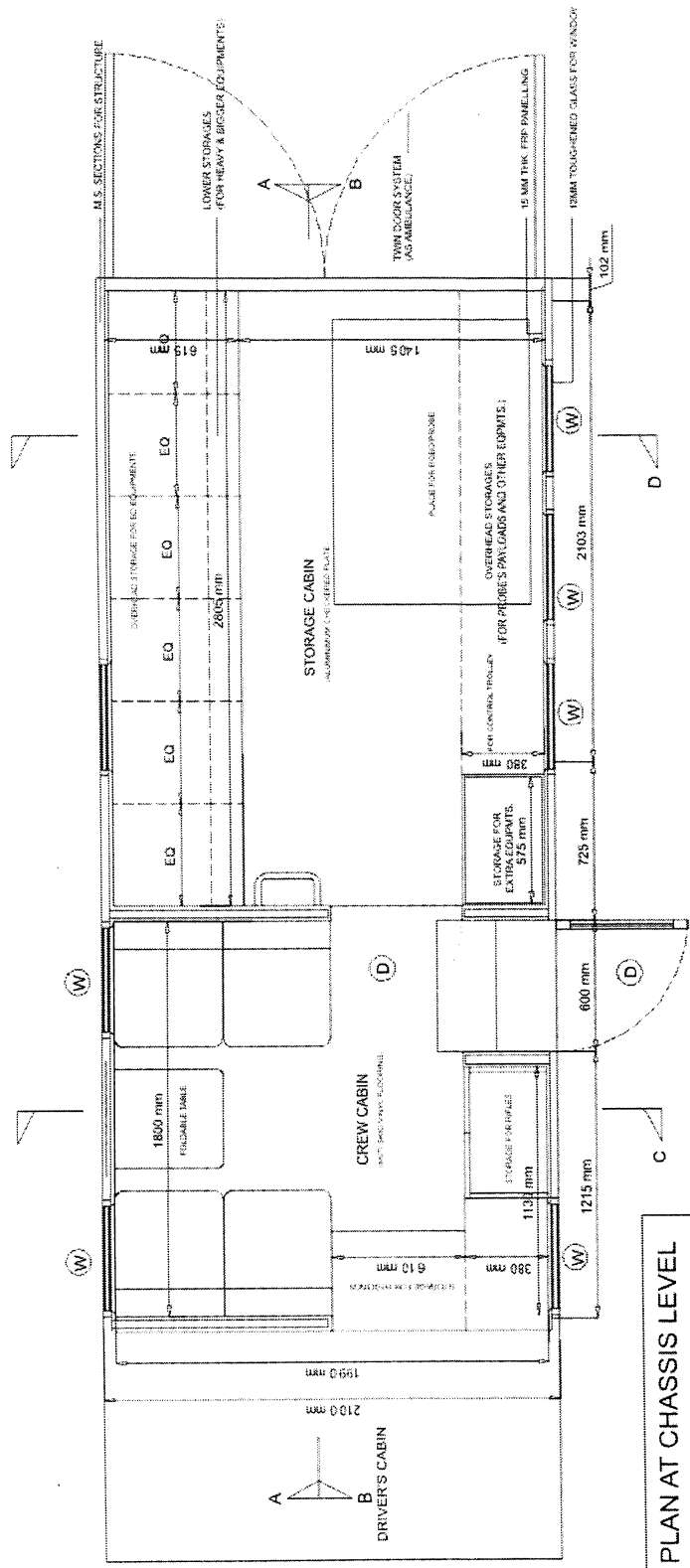


Fig. 4.17 Plan at Chassis Level

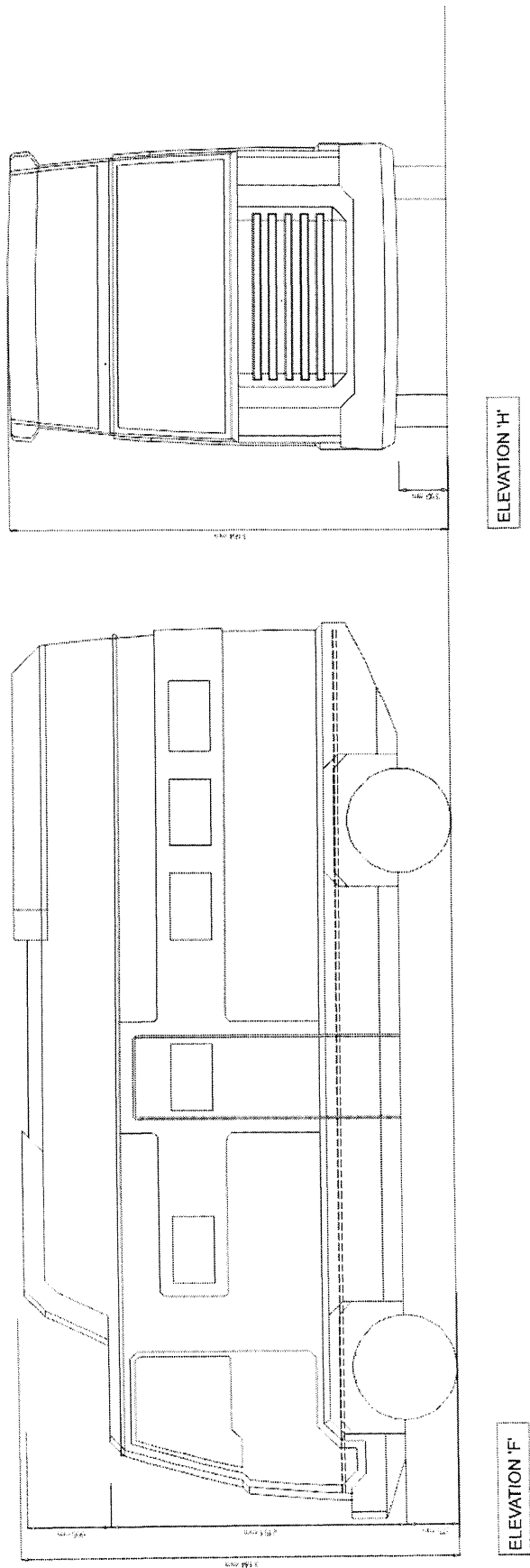


Fig. 4.18 Elevation F & H



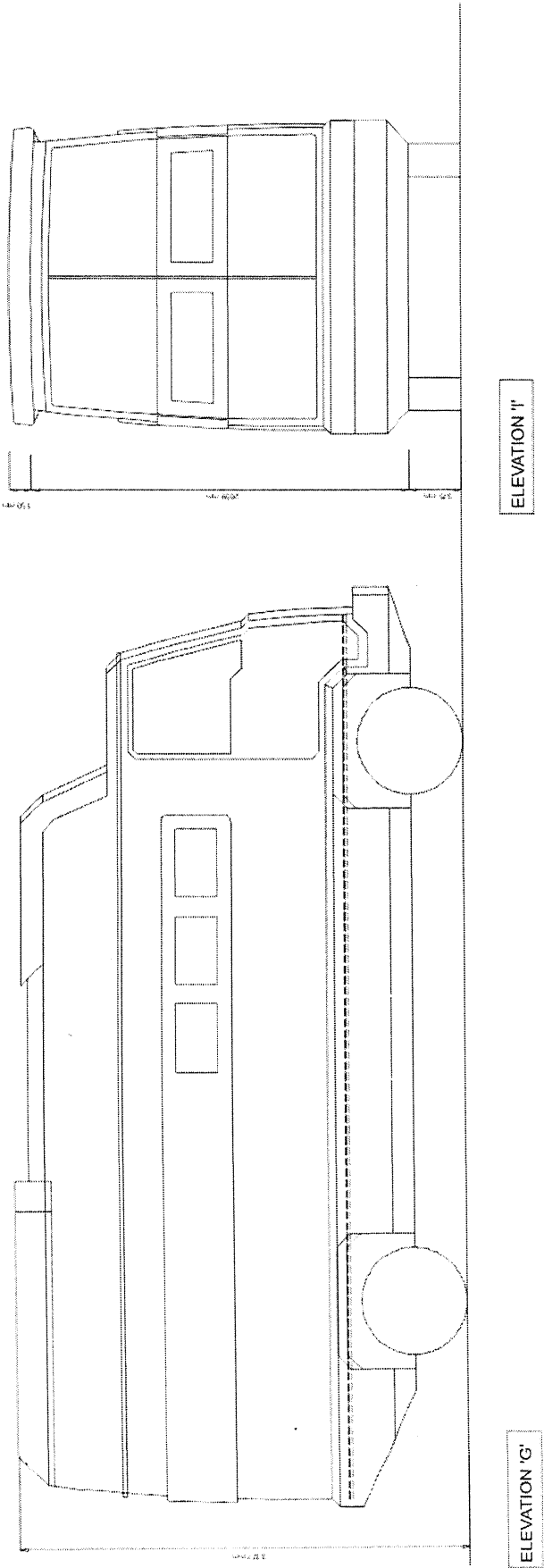


Fig. 4.19 Elevation G & I

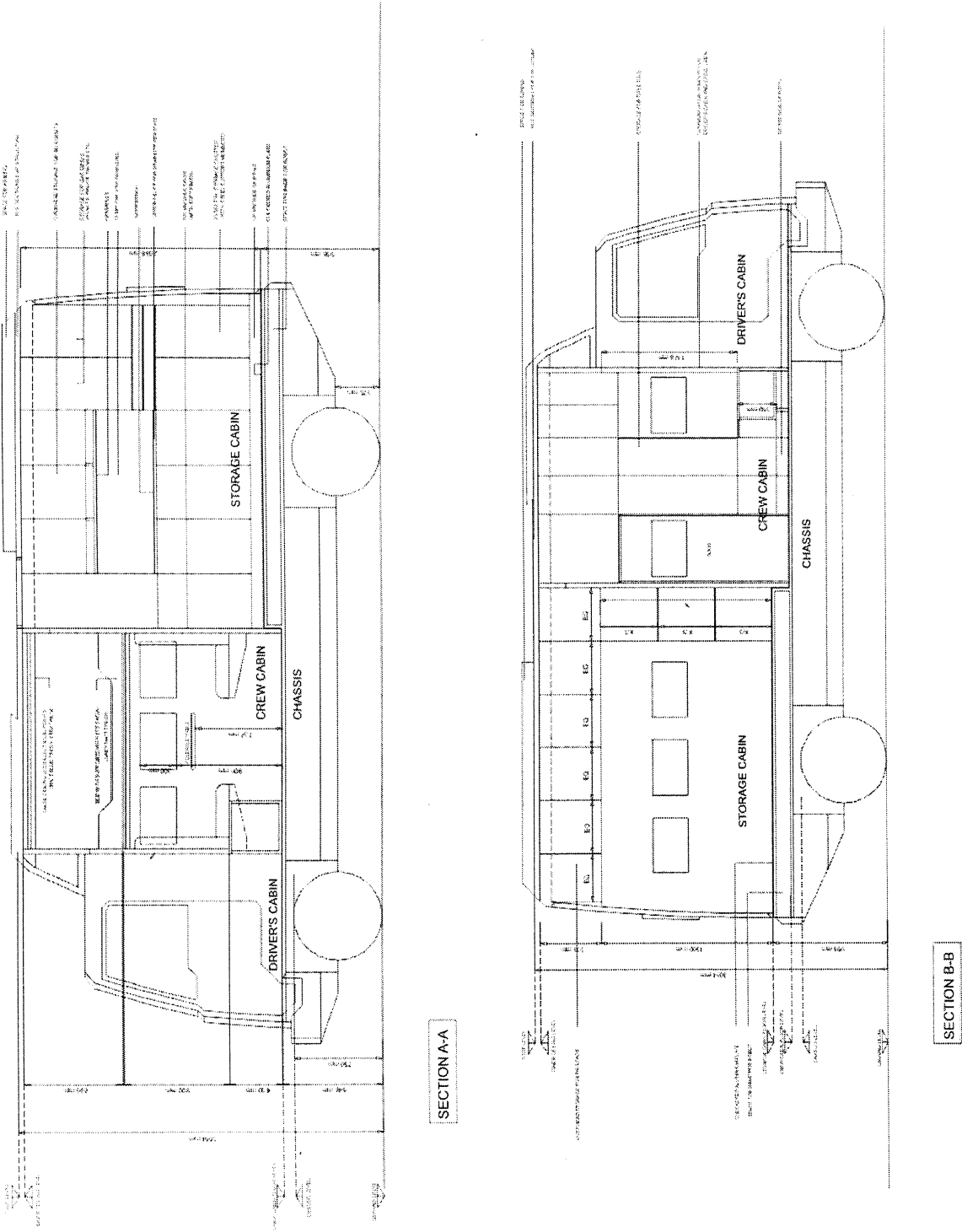
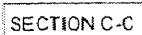


Fig. 4.20 Section A-A and B-B



**Fig. 4.21 Section D-D & C-C**

## Chapter 5

# CONCLUSION

### 5.1 SUMMARY

The Bomb detection and disposal squad is an important part of any armed forces establishment in developing and developed countries. The vehicle will cater to this team which has been serving the society without considering their own lives.

Thus, the aim of the thesis to provide a carrier vehicle for Bomb squad is fulfilled. The thesis involved the interaction and systems design to a large extent and without these two factors, the design would have failed.

One of the other main criteria that have affected the design is the technical details of the vehicle fabrication. Without the details of the structural members, the interior layout stand incomplete as the placement of light points, switch points, support members depends on it. On the other hand, the fixing of fiber reinforced paneling depends on the layout of the structural members. Thus, the automotive design involves the Concurrent design to a large extent. Concurrent design here means the involvement of Designer, Client, Fabricator, Consultants at the same point of time thus reducing the time involved in the fabrication and also the errors.

The vehicle will undergo fabrication by the month of August 2004 and shall take around 3 months for completion.

## 5.2 SCOPE FOR FURTHER WORK

The vehicle can undergo the second stage of prototyping with following changes

- Instead of taking the Swaraj Mazda's chassis as donor chassis, Ashok leyland's chassis can be used for the purpose. That will solve two problems i.e., space crunch and the loading it can take. The vehicle has to undergo many hardships thus Ashok Leyaland's chassis will be a better choice in such conditions.
- Presently, the design is catering only to the urban condition which is not always the case of bomb threatened areas. So, the next prototype can look after the off-road conditions and with higher degree of safety and security for crew.
- Presently, the vehicle does not carry the bomb disposal equipments to the full extent because of the security and safety criteria of the crew. The next prototype can arrange for the equipments to be carried.
- All the joineries and moving parts to be made stronger and optimized on the basis of data collected after testing of the first prototype.

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